Technical Memorandum

Ambient Air Quality Survey in the Vicinity of Great Lakes Forest Products Limited Dryden, Ontario

July, 1985

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Prepared by:

R.W. Bell, M.Sc.
Senior Project Scientist
and
D. J. Ogner, M.A.Sc., P. Eng
Senior Air Quality Survey Engineer

Air Quality and Meteorology Section
Air Resources Branch
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Executive Summary

At the request of the Northwestern Region of the Ministry of the Environment, Mobile Air Monitoring Unit #1 undertook an ambient air survey in the vicinity of the Great Lakes Forest Products Limited kraft and fine paper mill and secondary treatment system (lagoon) in Dryden between July 6th and 22nd, 1985.

The main purpose of this survey was to investigate gaseous emissions from the lagoon and mill complexes. Specific hydrocarbons and total reduced sulphur compounds were the designated contaminants of interest. Approximately 314 hours of continuously monitored ambient air data and 61 30-minute gas chromatographic samples were acquired during this survey.

The lagoon was found to be a significant source of total reduced sulphur compounds and hydrocarbons. It was also found that the concentration of these compounds decreased rapidly as the distance from the lagoon increased. The Provisional Guideline for TRS was not exceeded at the downwind sites off company property. However, levels above the nominal odour threshold were measured at nearby residences.

For monitoring on company property beside the lagoon, the maximum 30-minute average concentration of total reduced sulphur compounds was found to be 0.539 ppm (parts per million). The total hydrocarbon loadings ranged from 219 to 652 ug/m^3 (micrograms per cubic metre) and the aromatic fraction accounted for up to 74% of the total hydrocarbons detected. The most prominant aromatic was 1-isopropyl-4-methylbenzene (para-cymene). This is a naturally occurring hydrocarbon, derived from trees, for which there is no Environmental Guideline. Trichloromethane (Chloroform) was the dominant chlorinated organic detected in these on-site samples and its maximum loading was 196 ug/m^3 (its Environmental Guideline is 1,500 ug/m^3). For the off-site, downwind gas chromatographic samples, the total hydrocarbon loadings were at or near background levels. For all the other common contaminants such as oxides of nitrogen, carbon monoxide and ozone, all concentrations were found to be at or near background levels.

From measurements acquired downwind of the main mill complex, the Provisional Guideline for the total reduced sulphur compounds was exceeded during 4 of the 16 applicable monitoring periods. The maximum 30-minute average concentration of total reduced sulphur compounds reported for this phase of this study was 0.154 ppm - i.e. over 5 times the Guideline. These measurements of TRS were in general agreement with the concentrations monitored by northwestern Region's fixed station over the past few years. At all sites, the nominal odour threshold for TRS was exceeded. From the analyses of the 31 gas chromatographic samples acquired downwind of this mill, all hydrocarbon loadings were considered to be at or near background levels. For all the other common contaminants such as oxides of nitrogen, carbon monoxide and ozone, the concentrations were found to be at or near background levels.

Levels of particulate matter monitored in the vicinity of the lagoon were generally very low. The major source of particulate matter for the two samples which exceeded the air quality criterion was road dust. Only small amounts of foam from the lagoon were detected on occassion at each of the four sampling locations.

Introduction:

At the request of the Northwestern Region, Mobile Air Monitoring Unit #1 (MAMu #1) of the Monitoring and Instrumentation Development Unit of the Air Resources Branch undertook an ambient air monitoring survey in Dryden from July 6 to July 22, 1985. This survey resulted from a recommendation in the report on "Foam and Odours from the Secondary Treatment System operated by Great Lakes Forest Products Limited, Dryden" by H.D. Griffin, Chief, Air Quality Assessment, Northwestern Region, February 1985. As stated in this report, the purpose of the survey was ".....to identify and measure the concentrations of gaseous pollutants around the system. Such a survey would reveal the compounds which cause offensive odours in the area".

Great Lakes Forest Products Ltd. operates a kraft and fine paper mill on the west bank of the Wabigoon River in Dryden, Ontario. The mill site dates back to the early 1900's, but during the early 1980's, eighty percent of the kraft pulp mill was replaced and the capacity was increased from 190,000 t/year (metric tonnes per year) to 225,000 t/year. Production at the new pulp mill began in December 1982, while the new 148,000 sq. ft. stud lumber mill began operating at full capacity in May, 1983. As part of the mill improvements, a 115 acre secondary aeration system was added to the existing clarifier. This system, which will be referred to as the "lagoon" in this report, provides secondary treatment for the liquid effluent from the plant after the suspended solids have been removed in the clarifier. The lagoon consists of a 57 acre pond containing 27 mechanical aerators, a 22 acre settling pond and a 36 acre stilling zone. The entire lagoon holds approximately 200 million gallons and its purpose is to add oxygen to the effluent and reduce toxicity. Photographs of the mill and the lagoon are shown in Figures 1 and 2 respectively.

The monitoring program was divided into four major components:

1. Lagoon studies
2. Downwind monitoring of mill emissions
3. Fixed location overnight monitoring
4. Particulate monitoring in the vicinity of the lagoon

FIGURE 1 - VIEW OF GREAT LAKES FOREST PRODUCTS LTD.

MILL IN DRYDEN LOOKING EAST.

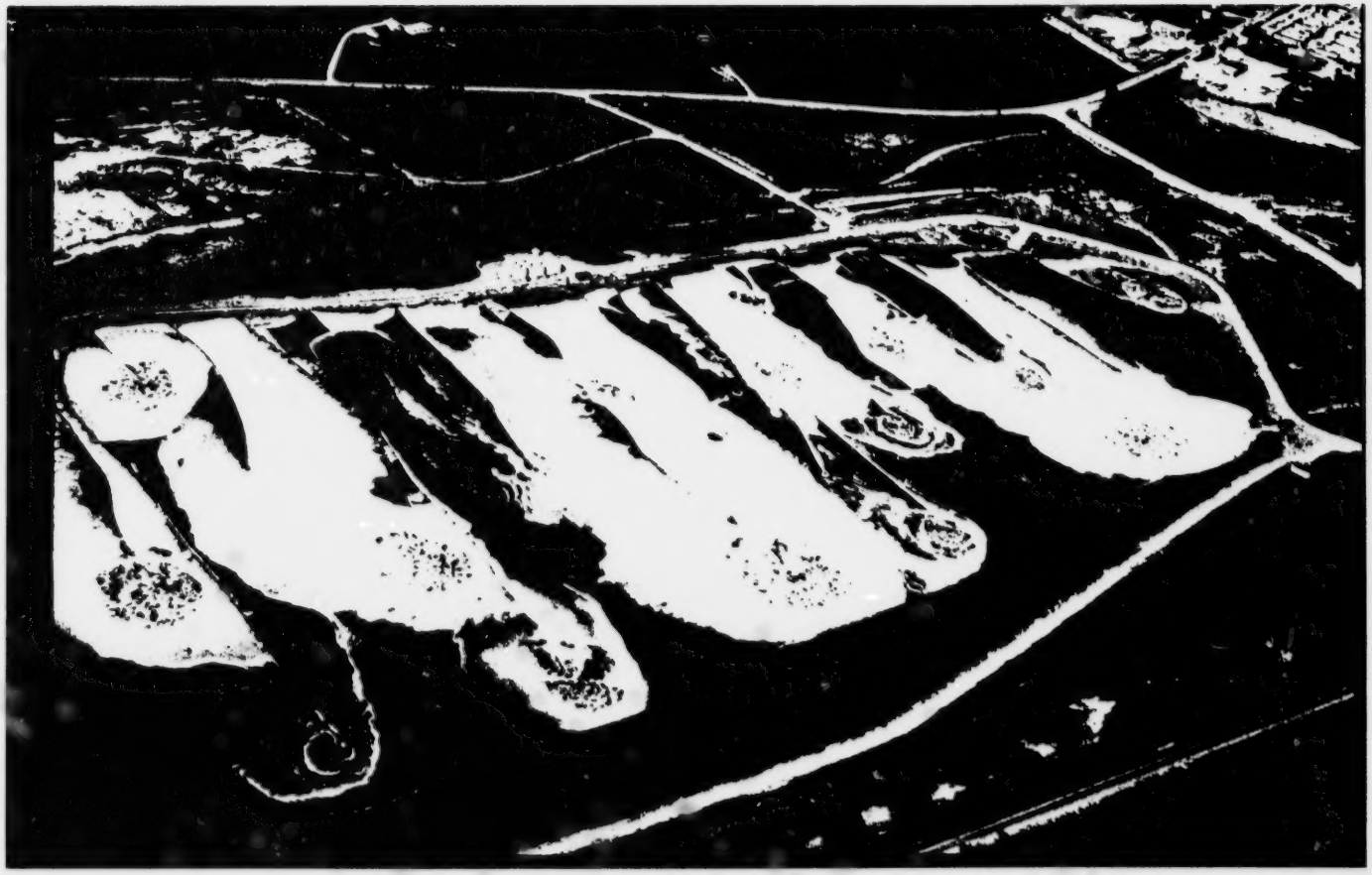


FIGURE 2 - VIEW OF LAGOON LOOKING NORTH SHOWING FOAM CREATED BY AERATORS.

This strategy made full use of the time spent by MAMu #1 in Dryden and broadened the original purpose by including emissions from the mill. The lagoon studies consisted of four different monitoring schemes:

a) monitoring within 2 meters of the surface of the lagoon using a special inlet line and funnel (see Figures 3a and 3b);
b) monitoring within a few meters of the edge of the lagoon using the standard MAMu inlet which samples at 5 meters above ground level;
c) monitoring downwind of the lagoon, off company property, using the standard MAMu inlet (see Figure 4); and
d) monitoring upwind of the lagoon to determine background concentrations.

This approach permitted an evaluation of the emission from the lagoon and the downwind variation in concentration. An additional feature was included in some of the surface monitoring periods. A special scrubber was switched into the sample line just before the total reduced sulphur monitor (TRS) in order to measure the concentration of carbonylsulphide (COS) and carbon disulphide (CS_2) (referred to as C_xS_x).

In this report, the monitoring periods (MP) are coded to indicate the Mobile Air Monitoring Unit, the day of the month and the the sampling period on that day. For example, monitoring period A062, decodes as follows: "A" represents MAMu #1; "06" refers to July 6, 1985, and "2" is the second monitoring period of that day. Frequently a calibration run is made before the field monitoring program is started. This is usually coded as "1" for the first monitoring period of the day. The data for calibration periods are not reported.

The monitoring periods for the lagoon studies are summarized in Table 1a. The location of the monitoring sites is shown on the map in Figure 5a.

For the downwind monitoring of the mill emissions, an attempt was made to locate MAMu #1 at a site where the emissions from the mill would impinge (i.e. touch) the ground. This was determined by visual

Table 1a

Summary of Lagoon Study Monitoring Periods

Monitoring Period (MP)	Date July '85	Start Time	Duration (Hours)	# of GC Samples	Location (Figure 5a)	Comments
A) Less than 2 m above Surface						
A122	12	12:29 pm	1.3	2	Lagoon Outlet(B)	
A172	17	11:35 am	1.6	2	Spill Barrier(C)	
A174	17	3:00 pm	0.6	1	Spill Barrier(C)	
A193	19	12:55 pm	1.5	2	Main Dock(A)	
Beside Main Inlet						
A113	11	12:49 pm	1.1	1	Main Inlet to Lagoon(D)	
Special Scrubber						
A114	11	1.58 pm	2.3	2	Main Inlet to Lagoon(D)	
A123	12	2:09 pm	0.7	-	Lagoon Outlet(B)	
A173	17	1:19 pm	1.6	1	Spill Barrier(C)	
A194	19	2:27 pm	1.1	1	Main Dock(A)	
B) 5 m Above Surface						
A112	11	10:52 am	1.8	2	Main Dock(A)	
A162	16	12:36 pm	1.9	1	Pump House(E)	
A171	17	10:36 am	0.9	1	Spill Barrier(C)	
A192	19	10:50 am	2.0	1	Main Dock(A)	
C) Downwind						
A073	7	12:29 pm	1.7	-	Smith Residence on Johnston Rd.(F)	300 m North*
A142	14	12:40 pm	2.7		Clarifier Rd.	100 m East*
A154	15	1:28 pm	2.6	3	Rissanen Residence Wilson Rd.(G)	175 m South*
A161	16	10:18 am	2.0	2	Smith Residence on Johnston Rd.(F)	300 m North*
A195	19	3:42 pm	1.7	2	Clarifier Rd.(H)	100 m East*
D) Upwind						
A083	8	3:28 pm	1.1	2	Marguerite & Hwy 17(I)	
Total	19 MP		30.2	29		

*Distance measured from nearest edge of lagoon.

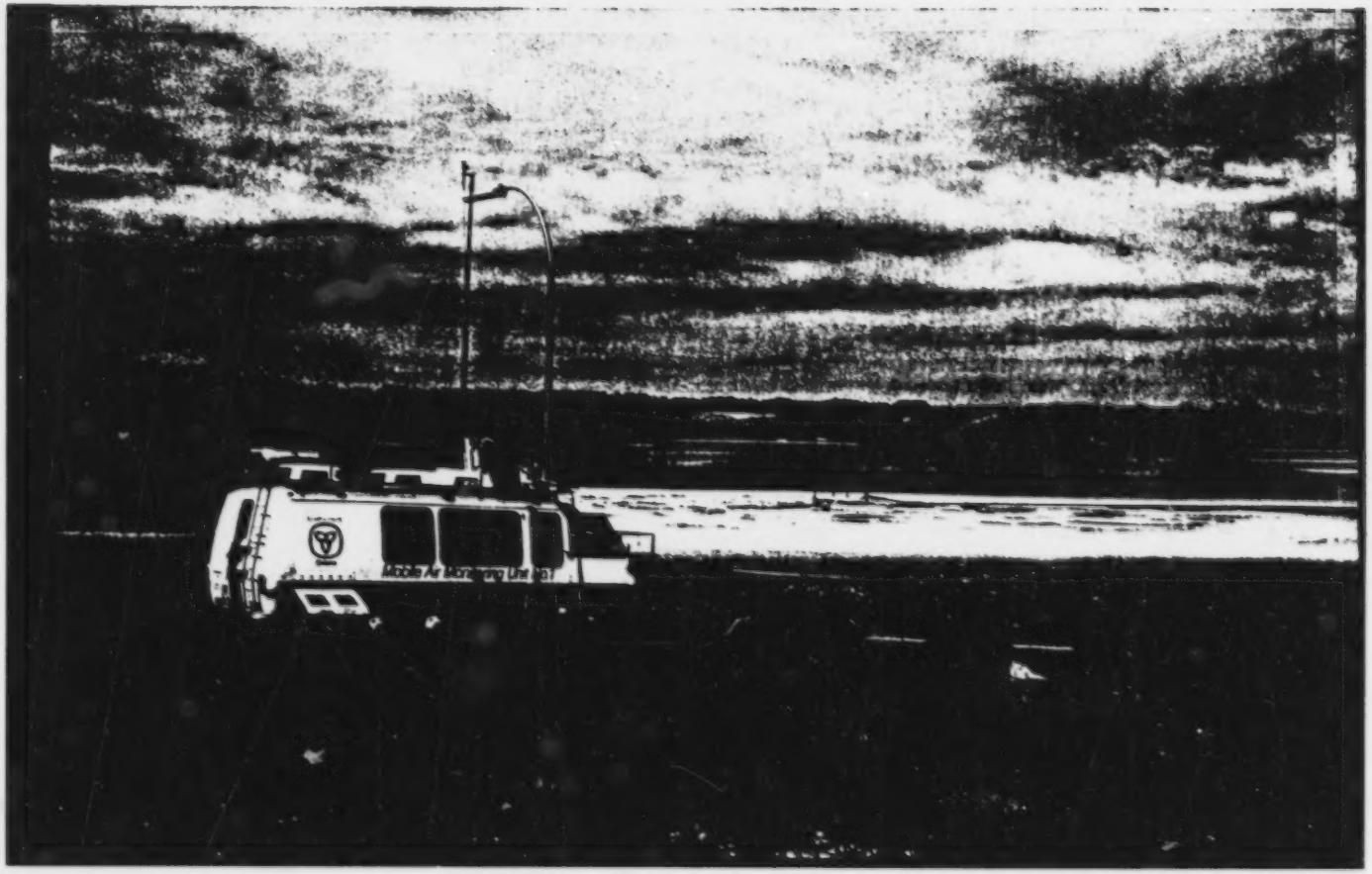


FIGURE 3A - MONITORING NEAR SURFACE OF LAGOON USING SPECIAL INLET LINE AND FUNNEL (MP A112).

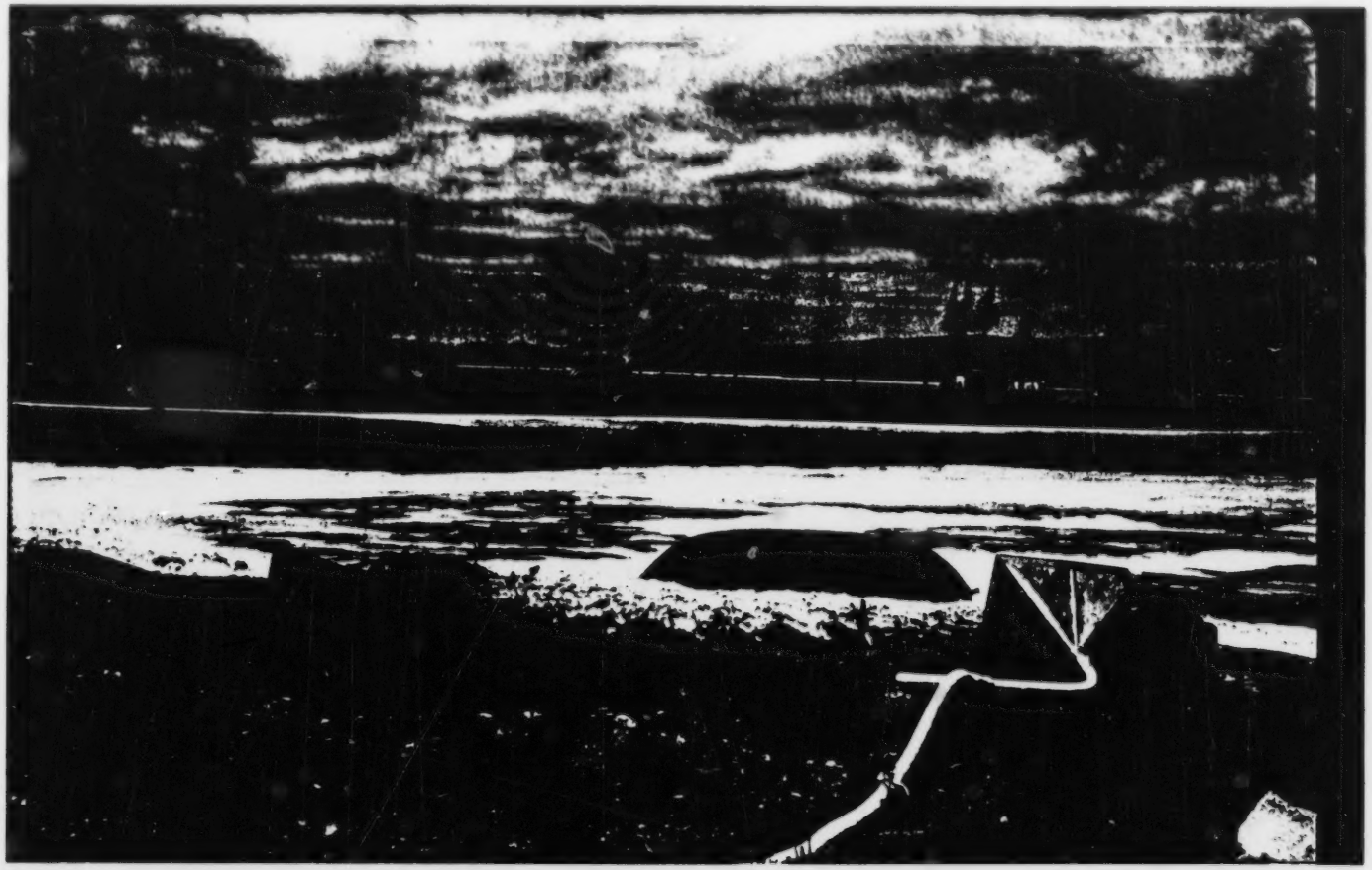


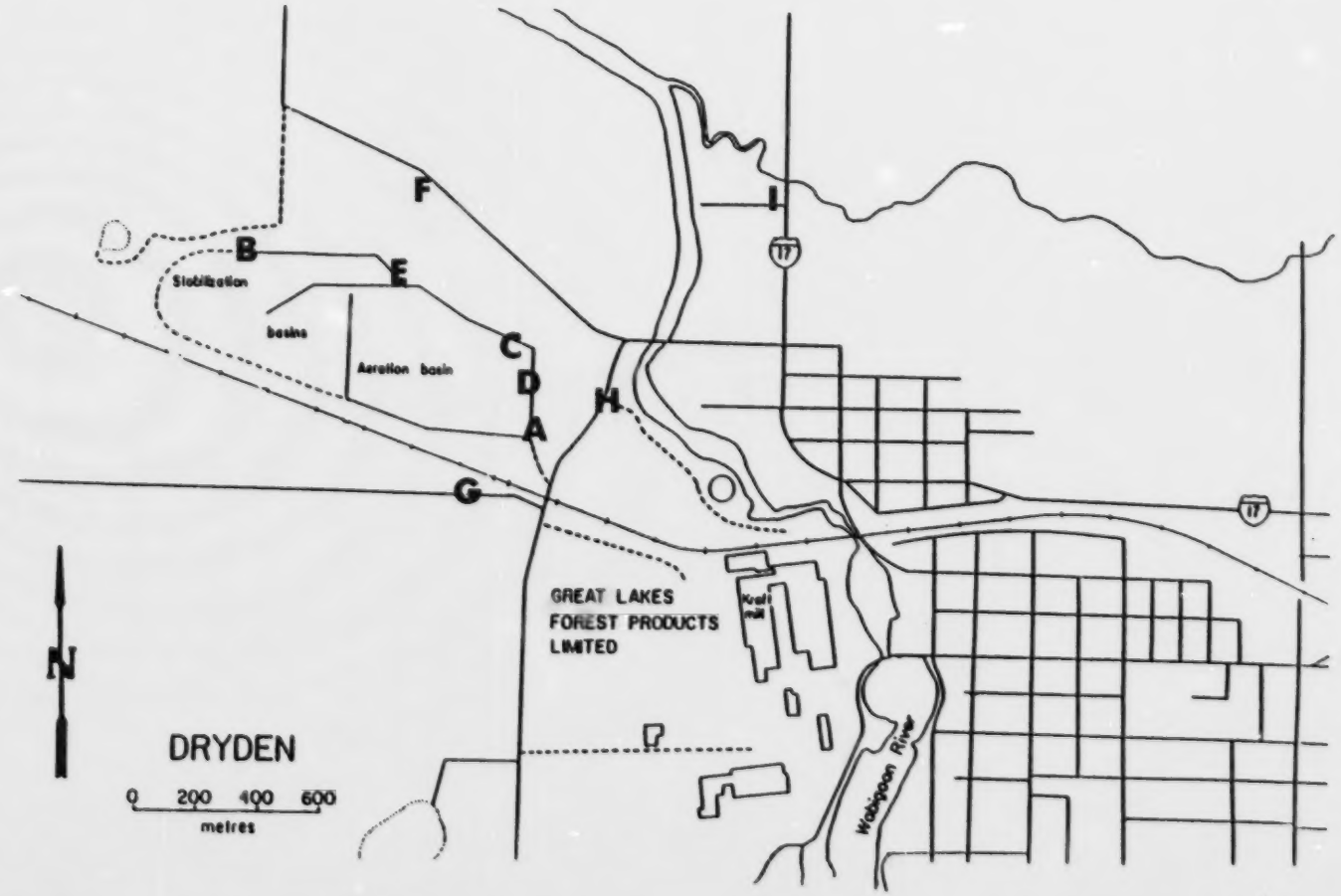
FIGURE 3B - SPECIAL INLET LINE AND FUNNEL POSITIONED CLOSE TO LAGOON INLET (MP A113).

FIGURE 4 - MONITORING DOWNWIND OF LAGOON USING STANDARD INLET (MP A154)

Figure #5a Monitoring Site Locations.....Lagoon Studies

A- Main Dock Area B- Lagoon Outlet C- Spill Barrier D- Main Inlet E- Pump House

F- Smith Residence G- Rissanen Residence H- Clarifier Road I- Marguerite & Highway #17



observation of the plume, by smell and by experience based on the meteorological conditions. On occasion, a change in wind direction would necessiate a move by the MAMu.

The fixed location overnight monitoring was conducted at the Ministry of Natural Resources (MNR) parking lot where the MAMu #1 was stationed when it was unattended. This site is located in the northeast part of Dryden as shown in Figure 5b. It was a good location to measure background concentrations when the wind was not blowing from the direction of the mill or the lagoon since at this site, MAMu #1 ran on external electrical power and hence there were no emissions from its internal gasoline-powered electrical generators. When the wind did blow from the direction of the mill or the lagoon it provided concentration measurements at the eastern edge of Dryden.

The monitoring periods for the downwind monitoring of the Great Lakes Forest Products Ltd. mill emissions and the MNR overnight monitoring are summarized in Tables 1b and 1c respectively. The locations of the monitoring sites are shown in Figure 5b.

The instrumentation of MAMu #1 is presented in Table 2.

There are basically two types of monitoring instrumentation carried onboard MAMu #1. These are the continuous monitors and the gas chromatograph (GC). Each continuous monitor samples and analyzes the air for a single component on a continuous real-time basis. A computer system interrogates each monitor every 5 to 10 seconds and at the end of every minute (5 minutes for the overnight periods), it computes the average for the previous minute and stores it as a data point. Subsequent 1/2-hour or 1-hour running averages are calculated to compare with the Ministry's Point of Impingement Standards or Ambient Air Quality Criteria respectively. The continuous monitors analyze for the "classic" or "common" air pollutants consisting of:

- Carbon monoxide (CO)
- Nitrogen Monoxide (NO)
- Nitrogen Dioxide (NO_2)
- Oxides of Nitrogen (NO_x)
- Ozone (O_3)
- Total Reduced Sulphur compounds(TRS)

Table 1b

Summary of Downwind Monitoring Periods for Mill Emissions

Monitoring Period	Date July '85	MAP I.D.	Start Time	Duration I.D.	# of GC (Hours)	Location Samples	Comments
A072	7	A	10:13 am	2.0	3	Johnston Park	Main Plume Aloft
A081	8	B	10:40 am	1.9	3	SE Corner of Kilpatrick & Albert	Slight Sulphurous Odour
A082	8	C	12:44 pm	2.4	4	Kinsmen Pk-Holland at Van Horne	
A091	9	D	10:29 am	5.1	4	Victoria & Riverview - Town Dock	High Winds - TRS Exceeds Guideline
A102	10	E	10:17 am	2.3	2	Park on West River Rd. in front of Mill	Wind Shift
A103	10	D	12:42 pm	3.3	3	Victoria & Riverview - Town Dock	TRS Exceeds Guideline
A132	13	E	10:13 am	1.1	1	Park on West River Rd. in front of Mill	Main Plume Aloft
A141	14	F	9:30 am	2.9	-	Albert & Van Horne	GC Down
A152	15	G	9:59 am	1.1	1	Strong Sulphurous Odour Whyte & Arthur Community Centre	Strong Sulphurous Odour
A153	15	D	11:11 am	1.9	2	Victoria & Riverview - Town Dock	Winds Shifting
A182	18	H	10:50 am	1.0	-	West River & Aubrey (Sid's Bait Shop)	GC Down

Table 1b (Cont'd)

Summary of Downwind Monitoring Periods for Mill Emissions

Monitoring Period	Date July '85	MAP I.D.*	Start Time	Duration (Hours)	# of GC Samples	Location	Comments
A183	18	I	11:59 am	1.9	-	Olson's Landing Rd. W of Mill (Near Woodlands Pkg Lot)	GC Down
A184	18	J	1:52 pm	2.3	-	Olson's Landing Rd. W of Mill (100 m S of Dump Road)	GC Down Sulphurous Odour
A196	19	G	5:37 pm	1.0	1	Community Centre E of Earl Ave.	TRS Exceeds Guideline
A201	20	G	10:48 am	3.3	4	Community Centre E of Earl Ave.	
A211	D	21	10:21 am	2.9	3	Victoria & Riverview - Town Dock	Plume Downwash Sulphurous Odour
Total 16 MP			36.4	31			

*Figure 5b

Table 1c
Summary of Overnight Monitoring Periods
at MNR Parking Lot

Monitoring Period	Date July '85	Start Time (pm)	Duration (Hours)	Comments
A061	6	2:47	17.5	
A074	7	2:57	17.4	1GC Sample
A092	9	3:50	16.5	
A104	10	4:26	16.3	
A115	11	4:34	15.8	
A124	12	4:11	16.3	
A133	13	12:30	19.8	
A143	14	4:42	15.8	
A155	15	4:22	16.3	
A163	16	5:35	15.0	
A175	17	3:59	16.3	
A185	18	4:52	16.2	
A197	19	6:55	13.6	
A202	20	4:08	16.4	
A212	21	2:35	18.1	
Total 15 MP			247.3 Hr	

Figure #5b MONITORING SITE LOCATIONS

Mobile Air Monitoring Sites.....alphabetic notation (mill)
Hi-Vol Sampling Sites.....numeric notation (lagoon)
Ministry of Natural Resources....overnight monitoring...*

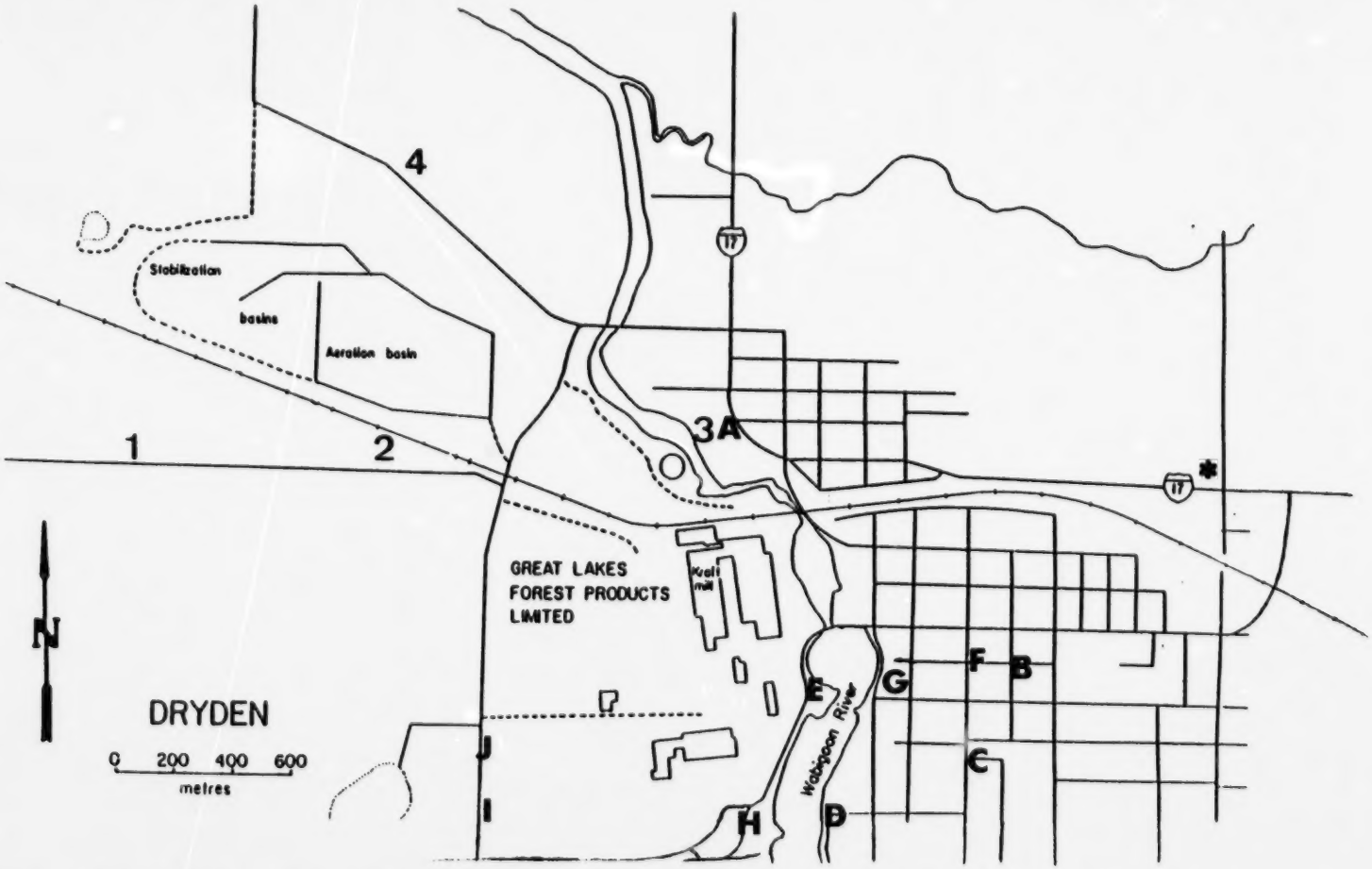


TABLE #2

THE INSTRUMENTATION OF MOBILE AIR MONITORING UNIT #1

Instrument	Manufacturer	Analytical Technique	Full Scale Sensitivity
THC, CH4, TH-M analyzer	Ingenieur-Produktions-Gruppe Munchen (IPM) RS-t	Dual flame ionization	50 ppm THC (as CH4)
H2S,SO2,NOx sources	Hartmann & Braun Prufgasgenerator	N/A	N/A
TRS/SO2 analyzer*	Monitor Labs 8850 c/w ML 8770	Fluorescence	1.0 ppm SO2 0.5 ppm TRS
NOx, NO2, NO analyzer	Monitor Labs 8840	Chemi-Luminescence	1.0 ppm NOx (as NO2)
CO analyzer	Thermo Electron P48	Gas Filter Correlation	100 ppm CO
O3 analyzer/ source	Dasibi 1003-AAS	UV Absorption	1.0 ppm O3
CO & THC sources	Matheson	Compressed Gas	N/A
Gas Chromatograph	HP 5880 Dual Capillary Column	Flame Ion-ization Det.	as set per calibrations

Meteorological Instrumentation

Instrument	Manufacturer	Scale
** Wind speed	Lambrecht GmBH	km/hr
** Wind direction	Lambrecht GmBH	degrees
Temperature	Weather Measure (WM) T621	degrees Celsius
Humidity	WM-HM-11P	absolute & %
Barometric pressure	WM-BM70-B242	millibars
Solar Radiation	WM Star Pyranometer	milliwatts/cm2

** These instruments are located on top of a 10 metre retractable tower

* Individual TRS compounds cannot be measured with this instrument

In addition, meteorological parameters consisting of wind speed (WS), wind direction (WD), temperature (Temp), humidity (Humidity), barometric pressure (Barom), and solar radiation (Solar Rad) are continuously monitored in the same way as the common contaminants.

The analyses/measurements of organics were performed by a dual capillary-column gas chromatograph (GC) prefaced by a cryogenic Trace Organic Preconcentrator (TOP). Ambient air was drawn through the TOP and the organics were adsorbed onto a Florisil / Molecular Sieve /Spherocarb cartridge (usually for one-half hour) and then thermally desorbed and introduced on the column heads of the GC. It should be noted that the organics analyses were performed on discrete ambient air samples whereas the common contaminants were continuously monitored. In addition, total hydrocarbon monitoring was also accomplished by another dedicated instrument housed in MAMu #1. This was a dual flame ionization detector system capable of monitoring, on a continuous basis, total hydrocarbon concentrations (THC) along with its methane (CH_4) and non-methane hydrocarbon fractions (TH-M). This instrument was used as quantitative backup for the GC sampling and analyses.

The tabular daily statistical print-outs for the 30-minute average ground level concentrations (glc's) and their respective time/concentration graphs for the continuously monitored contaminants, prefaced by an explanatory note are included in the appendix of this report. Similarily, the GC analytical results are also presented in the same appendix and prefaced by a brief description regarding the operation of the gas chromatograph. Finally, the statistics for the merged data sets are presented at the very end of this appendix.

For the particulate monitoring programme in the vicinity of the lagoon, the four locations as shown in Figure 5b and as described in Table 3 were utilized. At each location, a standard High Volume Air Sampler (Hi-Vol) equipped with a flow controller to maintain a constant flow of 40 cubic feet per minute was operated for 24 hours periods on consecutive days. The Hi-Vol sampler collected suspended particulate matter in the range of 0.3 micrometers to over 100 micrometers in diameter on an 8 inch by 10 inch glass fibre filter. Each filter was analyzed gravimetically

Table 3

Location of Particulate Monitoring Sites

Station Name	Location	Distance and Direction from Station to Lagoon	Distance and Direction from Station to Mill	Wind Direction From Lagoon To Station	Wind Direction From Mill to Station
1. Wilson Residence	North Side of Wilson Rd. 1000 m West of Olson's Landing Road	500 m SW	2000 m WNW	35°-85°	100°-115°
2. Mathews/ Rissanen Residence	North Side of Wilson Rd. 350 m West of Olson's Landing Road	125 m S	1300 m WNW	310°-70°	100°-130°
3. Johnston Park	Grand Trunk Ave. and Florence St.	750 m E	700 m N	270°-290°	155°-190°
4. Smith Residence	North Side of Johnston Rd. 400 m West Of Olson's Landing Rd.	300 m N	1600 m NNW	155°-255°	140°-160°

(i.e., by weighing) to determine the average mass concentration expressed as total suspended particulate (TSP) in units of micrograms per cubic meter of air (ug/m^3). Each sampling period lasted from about 10 am one day to 10 am the following day. Sampling started at all 4 stations on the morning of Sunday July 7 and continued to Monday July 22, 1985. For the last 4 days, only the Mathews/Rissanen station was operational.

Daily Discussions and Results

July 6

A low pressure system pushed through Dryden early Friday and this being Saturday, Dryden was under the influence of a weak high pressure area. The air mass was drying out and becoming more stable. However, the frontal system associated with low pressure area was pushing into this area and was expected to pass through overnight. The winds were light to moderate and southerly. For example, at 1400 hrs local time, an overcast condition existed with scattered towering cumulus, scattered altocumulus and scattered cirrus with the winds from 160 degrees at 14 km/hr. The dew point depression was 8°C (Celsius) and the ambient temperature was 22°C.

Mobile Air Monitoring Unit #1 (MAMu #1) was brought on-line Friday. Saturday morning was reserved for calibrations and response verifications for all instruments. Once these procedures had been followed, a general air quality monitoring programme for the common contaminants was initiated at the Ministry of Natural Resources (MNR) parking lot.

Commencing at 2:42 pm, 17.5 hours of ambient air data were acquired and the results are denoted by monitoring period (MP) A061. For the common contaminants, the maximum 30-minute average ground level concentrations (glc's) of TRS, NO_X and CO were 0.010, 0.008 and 0.63 ppm (parts per million) respectively and the overall arithmetic mean glc's (for the entire monitoring period) were 0.003 (TRS), 0.005 (NO_X) and 0.26 ppm (CO). Some sulphurous odours were detected by the staff at this site and this is reflected by the TRS results. The odour threshold for TRS is of the order of 0.005 ppm and the Environmental Provisional Guideline (based on a 30-minute average glc measurement) is 0.027 ppm. Low concentrations of hydrocarbons were also monitored at this site. As measured by the continuous hydrocarbon analyzer, the maximum 30-minute average and overall mean glc's of TH-M were 0.44 and 0.32 ppm respectively. Apart from the TRS results, all other glc's could be considered to be at or near background levels.

July 7

The incumbent frontal system pushed through Dryden overnight and due to subsidence behind this system, the air mass was generally dry and stable. The winds were light to moderate and veered from southerly to westerly throughout the day. The dew point depression was again of the order of 8 to 10°C and the ambient temperature was in the mid-twenties.

An initial investigation of gaseous emissions downwind of the plant and of the lagoon were deemed possible on this date.

The winds were light and southerly at 10 am and because of this, MAMu #1 monitored north of the mill. At Johnston Park, MAMu #1 commenced acquiring ambient air data at 1012 hrs - MP A072. The main plumes from the mill were travelling aloft and passing directly overhead of the monitoring unit. Low glc's were measured and very little impingement was noted at this site. From the 2 hours of monitoring the common contaminants, the overall average and the maximum 30-minute average glc's of TRS, NO_X and CO were 0.006, 0.008, 0.71 pm and 0.007, 0.011 and 0.89 ppm respectively. Low glc's of the hydrocarbons were also measured at this site. The maximum 30-minute average glc of TH-M was 0.28 ppm and the overall mean glc was 0.17 ppm. From the three 30-minute GC samples acquired at this site, the total hydrocarbon loadings average 76 ug/m^3 (86, 74 and 67 ug/m^3) and the alkane fraction comprised (on the average) 59% of these loadings and the aromatic fraction 28%.

Because little success was achieved in positioning MAMu #1 in the impingement zone downwind of the mill, the preliminary investigation of emissions from the lagoon was then undertaken.

MAMu #1 was positioned on Johnston Road, off plant property, downwind of the main lagoon and just in front of the Smith's residence. As noted by MP A073, the winds were southerly and moderate (up to 18 km/hr but averaging approximately 10 km/hr). Once again because of essentially good dispersion conditions, low glc's were measured at this downwind site. From the 1.5 hours of data acquired for the common contaminants, the overall mean and maxima 30-minute average glc's of TRS 0.005 and

0.007 ppm; of NO_x 0.006 and 0.007 ppm; and CO were: 0.69 and 0.71 ppm. Low glc's of hydrocarbons were also measured. For the non-methane hydrocarbons, the overall mean and maximum 30-minute average glc's were 0.07 and 0.08 ppm. From the three 30-minute GC samples, the total hydrocarbon loadings averaged 38 ug/m^3 (35, 40 and 38 ug/m^3) and the alkane fraction comprised approximately 52% of these totals and the aromatic 34%.

A point of note regarding the GC results acquired on this day. The GC library and software package in MAMu #1 has the capability of identifying over 120 different organic compounds based on retention indices. Downwind of the main plant, the GC library accounted for approximately 68% of the total peak area on the chromatograms whereas downwind of the lagoon, this area percent identified dropped to 48%. The reason for this was that an increase in the number of peaks at higher retention indices was noted in the lagoon samples and the library could not positively identify these additional peaks. However, these 'new' peaks did not match any of the existing retention indices thus they could not be identified. Several samples, acquired downwind of the lagoon, were then sent back to the main lab at 880 Bay Street in Toronto where they underwent GC/MS analyses. The largest peak in the higher retention index range was identified as 1-isopropyl-4-methylbenzene. On this day and downwind of the mill, 1-isopropyl-4-methylbenzene accounted for 8% of the total hydrocarbons whereas downwind of the lagoon, it accounted for 11%.

After 2 pm, MAMu #1 moved back to the Ministry of Natural Resources site where it was prepared for overnight monitoring and acquired data that could be considered as being indicative of upwind conditions (MP A074). One 30-minute GC sample was acquired upon arrival at this site and once again, the concentrations were low. The total hydrocarbon loading was 90 ug/m^3 and the alkane fraction comprised 74% of this total and the aromatic fraction 16% (1-isopropyl-4-methylbenzene comprised only 2% of this total). The overall mean glc of non-methane hydrocarbons as measured throughout the night was only 0.21 ppm and for NO_x 0.006 ppm. The CO and TRS analyzers developed problems and were inoperative overnight.

July 8

The airmass over Dryden on this date was dry and stable and moderate to strong (up to 30 km/h) westerly winds had evolved by 10 am. The sky condition was essentially scattered to broken fair weather cumulus. The dew point depression was in excess of 10°C and the ambient temperature was in the mid-twenties.

The emissions from the mill were being carried into the downtown area.

After the morning calibration, MAMu #1 moved to the corner of Kilpatrick and Albert Streets in downtown Dryden. MAMu #1 was positioned directly downwind of the mill and this site was deemed to be just at the edge of the impingement zone. A slight sulphurous odour was detected by the staff upon arrival at 10:30 am. Three 30-minute GC samples and 2 hours of ambient air data were acquired and the results are noted by monitoring period A081. For the common contaminants, the glc's were low. The maximum 30-minute average glc's of TRS, NO_x, 0_3 and CO were: 0.002, 0.011, 0.012 and 0.54 ppm respectively. The maximum 1-minute average glc of TRS was 0.009 ppm. Low hydrocarbon concentrations were also measured at this site. The maximum 30-minute average glc of non-methane hydrocarbons was 0.50 ppm. From the 3 GC samples, the total hydrocarbon loadings ranged from 79 to 213 ug/m^3 (a mean of 145 ug/m^3) with the alkane fraction comprising 61% of these totals and the aromatic 22%. The 1-isopropyl-4-methylbenzene contribution was 2%.

During these first two hours, the staff investigated other areas of downtown Dryden for a second possible site that would be more in the centre of the impingement zone. Just after 12:30 pm MAMu #1 was moved to the corner of Welland and Van Horne Avenue. The winds still persisted from the west and were strong (up to 30 km/hr). Commencing at 12:43 pm, MAMu #1 acquired over 2 hours of ambient air data and four 30-minute GC samples at this second site (A082). For the common contaminants, all glc's were low except for the total reduced sulphur compounds. The overall mean and maximum 30-minute average TRS glc's were 0.016 and 0.023 ppm. The

maximum 1-minute average TRS glc was 0.49 ppm. Similar glc's of hydrocarbons were also monitored at this second site as compared to the first site. The maximum 30-minute average glc of TH-M was only 0.32 ppm and the mean total hydrocarbon loadings determined from the 4 GC samples was only 75 ug/m^3 with essentially equal contributions from the alkane and aromatic fractions. The 1-isopropyl-4-methylbenzene contribution was now 30% of these total loadings.

An upwind monitoring site was selected at the corner of Marguerite Street and Highway #17. Unknown to the staff, this site was directly downwind of the town's sewage treatment plant. Nevertheless, monitoring was undertaken and relative low concentrations were measured (A083). One hour of ambient air data and two 30-minute GC samples were acquired at this site. Apart from TRS, low glc's for the common contaminants were measured. The overall mean and the maximum 30-minute average TRS glc's measured at this site were 0.008 and 0.011 ppm respectively. Low concentrations of hydrocarbons were also measured. The maximum 30-minute average TH-M glc was only 0.08 ppm and from the 2 GC samples, the total hydrocarbon loadings were 59 and 43 ug/m^3.

Additional calibration and maintenance work was performed on MAMu #1 when it returned to the MNR site. Because of this, no overnight monitoring was undertaken on this date.

July 9

A high pressure area settled over Dryden and the air mass was generally dry and stable. The dew point depression was approximately 15°C and the ambient temperature was in the high teens. Scattered fair weather cumulus and strong (up to 40 km/hr) northwesterly winds had developed by early afternoon.

Emissions from the mill were impinging on the downtown area and an investigation of these emissions was the proposed monitoring programme for this date.

After the morning calibration and maintenance programmes were completed, MAMu #1 moved to the public boat launch site at the junction of Victoria Street and Riverview Drive - A091. Commencing at 10:28 am, MAMu #1 acquired over 5 hours of ambient air data for the common contaminants and four 30-minute GC samples. Because of the strong winds, the plant emissions were being held close to the ground and were directly impinging at this site.

For the common contaminants, a significant increase in TRS and a moderate increase in CO glc's were measured at this site. The overall arithmetic mean and maximum 30-minute average glc's of CO measured at this site were 0.94 and 1.46 ppm respectively. The Provisional Guideline (0.027 ppm) for total reduced sulphur compounds was exceeded on this date. The overall mean and maximum 30-minute average TRS glc's measured during these 5 hours were 0.044 and 0.072 ppm respectively. The stack sampling unit of the Air Resources Branch reported at 11:30 am that the mill had problems with the main recovery stack and that they had cut back emissions to 120 ppm TRS as measured in the stack. Nevertheless, the measurements of TRS off plant property clearly indicated that the Provisional Guideline had been exceeded at this time and at this locale. The NO_x and O_3 glc's remained at or near background levels (i.e. 0.04 and 0.01 ppm respectively).

The continuous total hydrocarbon analyzer was inoperative at this time and the total hydrocarbon loadings determined from the 4 GC samples were similar to those reported earlier. From these samples, the total

hydrocarbon loadings ranged from 50 to 113 ug/m^3 (a mean of 83 ug/m^3) with the alkane fraction comprising 12% of these totals, and the aromatic fraction 84%. The 1-isopropyl-4-methylbenzene comprised 74% of the aromatic fraction.

After 3:30 pm, MAMu #1 moved back to the MNR parking lot area for overnight monitoring (MP A092). Since this site was outside of the impingement area, these results could also be considered as indicative of upwind measurements. No GC samples were acquired at this site and the total hydrocarbon analyzer was still inoperative. Due to the clear skies overnight, a well developed nocturnal inversion was present in the Dryden area (note the wind speed between 2100 and 0600 hrs). But since this site was outside the impingement area and not downwind of the mill, all reported glc's for the common contaminants were at or near background levels. For example, the overall mean glc's of CO and TRS measured at this site were 0.36 and 0.001 ppm respectively.

July 10

Dryden was still under the influence of a high pressure area and although not reflected by the surface meteorological observations, a weak cold front had pushed through overnight. The airmass was still dry and stable and the dew point depression was still greater than 10°C with the ambient temperature in the high teens. At 8:00 am, the sky condition was clear but by noon, it had deteriorated to a broken cumulus condition. The winds were moderate to brisk (in the 20 km/hr range) and still northwesterly.

Because of the winds, the mill emissions again were impinging in the downtown core of Dryden. Thus an investigation of these emissions was also undertaken on this date.

After the morning calibration, MAMu #1 moved over to a little park directly in front of the mill and on the east side of the West River Road. Commencing at 10:17 am, 2.3 hours of ambient air data and two 30-minute GC samples were acquired at this site - A102. Initially, the plant emissions were impinging directly at this site but as time passed, the winds veered by 10 degrees and by noon the emissions were impinging at the public dock area at Victoria and Riverview Drive. The CO analyzer and the methane side of the total hydrocarbon analyzer were inoperative during this monitoring period. NO_x and 0_3 concentrations were still at background levels - i.e. 0.04 and 0.006 ppm respectively. Considerable concentrations of TRS were measured initially (the maximum 30-minute average glc was 0.154 ppm - over 5 times the Environmental Standard) but dropped off to near background levels (0.004 ppm) at the end of the monitoring period. For the hydrocarbons, similar loadings were determined from the 2 GC samples and the total hdyrocarbon analyzer as compared to the previous work performed downwind of this mill. The overall average THC glc was only 1.44 ppm and if one assumed a background glc of methane of 1 ppm, the non-methane hydrocarbon glc's would be approximately 0.44 ppm. For the 2 GC samples, the total hydrocarbon loadings were 104 and 45 ug/m^3 (a mean of 75 ug/m^3) with the alkane fraction comprising approximately 25% of these loadings and the aromatic fraction 50%. The loadings of 1-isopropyl-4-methylbenzene were 31 and 14 ug/m^3.

After 12:30 pm, MAMu #1 moved to the public dock area at Victoria Street and Riverview Drive. The CO analyzer was brought back on-line but the methane side of the toal hydrocarbon analyzer still remained inoperative. Commencing at 12:41 pm, 3.2 hours of ambient air data for the common contaminants and the three 30-minute GC samples were acquired - A103. Again, apart from the TRS measurements, all other measurements of the common contaminants were at or near background levels - for example, the overall mean glc's of CO was 0.57 ppm, of NO_x 0.019 ppm and of 0_3 0.007 ppm. The TRS measurements depicted a wide range of glc's (from 0.001 to 0.084 ppm for a 1-minute average) and the TRS Provincial Guideline was exceeded between 1440 and 1530 hrs local time (the maximum 30-minute average glc was 0.039 ppm). Again if one assumed a methane background of 1 ppm, the non-methane hydrocarbon concentrations in this area would be approximately 0.8 ppm (the overall arithmetic mean glc of THC was 1.767 ppm). This small increase in the non-methane hydrocarbon glc's (0.8 versus 0.4 ppm) was also reflected in the GC results. From the analyses of the 3 GC samples, the total hydrocarbon loadings ranged from 48 to 217 ug/m^3 (with a mean of 132 ug/m^3) with the alkane fraction comprising 36% of these totals on an average and the aromatic fraction 50%. The contribution of 1-isopropyl-4-methybenzene ranged from 27 to 86 ug/m^3 for a mean contribution of 43% of the total hydrocarbon loading.

After 4 pm MAMu #1 moved back to the MNR site and sat up for overnight monitoring - A104. Rather than just background concentrations measured during this monitoring period, some significant glc's of TRS were measured at 2 am. By 2 am, another nocturnal inversion was well established (note the calm winds and low temperature profile at this time) and the maximum 30-minute average TRS glc was 0.006 ppm with a peak 1-minute average glc of 0.009 ppm. For all the other common contaminants, background or levels less than the minimal detectable limits for the analyzers were measured. The CO analyzer and the methane side of the total hydrocarbon analyzer were still inoperative during this overnight period.

July 11

The centre of the high pressure area had moved eastward and was located over Thunder Bay in the early morning. Dryden, being northwest of Thunder Bay, was experiencing moderate northwesterly winds and scattered fair weather cumulus. The air mass over Dryden was dry and stable. The dew point depression was greater than 10°C and the ambient temperature was in the high teens.

Up to this time, the majority of the field work had dealt with the investigations of emissions from the main mill. Today would be reserved for preliminary investigations of emissions from the lagoon as measured on plant property.

After the morning calibrations, MAMu #1 moved to the main dock area on the east side of the lagoon and began acquiring data at 10:52 am - MP A112. With the inlet of the sampling probe approximately 5 metres above the surface of the lagoon, 1.8 hours of data for the common contaminants and two 30-minute GC samples were acquired. For the common contaminants, only significant concentrations of TRS were measured. The largest maximum 30-minute average and overall mean TRS concentrations were 0.029 and 0.023 ppm respectively. From the two GC samples, the total hydrocarbon loadings were 311 and 206 ug/m^3 (a mean of 259 ug/m^3) with the alkane fraction accounting for 40% of these totals, the aromatic fraction 31% and the chlorinated species 22% (i.e. the sum of the chlorinated alkanes, alkenes and aromatics). The 1-isopropyl-4-methylbenzene loadings were 20 and 25 ug/m^3 (or 9%) and the area % identified peaks was approximately 24%.

The winds were backing slightly and just before 1 pm, MAMu #1 was moved to a site approximately 10 metres east of and downwind of the main inlet to this lagoon -MP A113. Just over 1 hour of data for the common contaminants and one 30-minute GC sample were acquired during this monitoring period. With respect to the common contaminants, only significant concentrations of TRS and TH-M were measured during this time. The largest maximum 30-minute average (and overall mean) TRS and

TH-M glc's were 0.539 (0.267) and 2.73 (2.39) ppm respectively. From the GC analysis of the single sample, the total hydrocarbon loading was 303 ug/m^3 with the alkane fractional loading of 41 ug/m^3, the aromatic fraction loading of 132 ug/m^3 and the chlorinated fractional loading of 121 ug/m^3. The 1-isopropyl-4-methylbenzene loading was 85 ug/m^3 and the area percent identified was 26%.

MAMu #1 remained at this site but just before 1400 hrs, the TRS sampling system was modified in such a manner that now the TRS analyzer would measure concentrations of CS_2 and COS. (A scrubber was placed in the sampling line just before the TRS analyzer and this scrubber removed all reduced sulphur compounds except for COS and CS_2. Studies were done on this sampling train back in the lab at Toronto and it was found that apart from COS and CS_2, all other reduced sulphur compounds were completely scrubbed out by this system. Some scrubbing was also performed on COS and CS_2 but the effect was considered to be minimal (of the order of a few per cent). Thus COS and CS_2 were measured by the TRS analyzer in this sampling train and the concentration amounts achieved are to be considered only as approximates). With reference to this monitoring period (MP A114), approximately 2.3 hours of data on the common contaminants were acquired. Once again, the only significant common contaminant concentrations measured were TH-M and C_XS_X (the combination of COS and CS_2). The largest maximum 30-minute average (and overall mean) concentrations of TH-M and C_XS_X were 2.47 (2.19) and 0.017 (0.013) ppm respectively. Thus when compared to the results obtained during MP A113, the C_XS_X contribution appeared to be approximately 5% of the total TRS compounds (0.013 versus 0.267 ppm) whereas the TH-M concentrations remained essentially the same - 2.19 versus 2.39 ppm. Two GC samples were also acquired during this monitoring period and the results were similar to that obtained during MP A113. From these two 30-minute samples, the total hydrocarbon loadings were 637 and 300 ug/m^3 (a mean of 469 ug/m^3) with the alkane fractional loadings of 285 and 29 ug/m^3 (or 34 % of the mean total hydrocarbon loading), the aromatic fractional loadings of 157 and 71 ug/m^3 (or 24%) and the chlorinated fractional loadings of 176 and 192 ug/m^3 (or 39%). The 1-isopropyl-4-methylbenzene loadings were 106 and 49 ug/m^3 and the average area percent identified was only 35%. It should also be noted that in these last 3 GC samples (i.e. during MP's A113 and A114), significant loadings of trichloromethane were also determined (109, 144 and

170 ug/m^3). The 0.5 hour Environmental Guideline for chloroform (i.e. trichloromethane) is 1500 ug/m^3. This organic accounted for over 90% of all the chlorinated organics reported and approximately 34% of the total hydrocarbon loadings determined at this site.

After 4:15 pm, MAMu #1 moved back to the MNR site and set up for overnight monitoring - reference MP A115. From 4:30 pm to 1 pm, the winds were moderate to brisk (up to 21 km/hr) and westerly. During this period, significant glc's of TRS were measured at this site. The largest maximum 30-minute average TRS glc was 0.017 ppm and the largest 1-minute average TRS glc was 0.051 ppm. At midnight, the winds weakened and subsidence was evident. This subsidence inversion was more pronounced around 4 am and at that time, the TRS glc's had increased from less than 0.002 pm to 0.008 ppm for the reported 30-minute average glc. No GC samples were acquired during this overnight period. For all the other common contaminants, background concentrations were measured.

July 12

Dryden's weather was still being influenced by the high pressure area that had now pushed into the Lake Michigan area. Up until mid-afternoon, the winds were light and variable and after that time, they became northerly and moderate (10 km/hr). The air mass was still relatively dry but was becoming unstable and the sky condition was clear to scattered. The dew point depression was still greater than 10°C and the ambient temperature was in the mid to high twenties.

Because of the light variable winds, further investigation of gaseous emissions from the lagoon was deemed possible on this day. Again, on site, on property ambient air measurements were undertaken.

The morning was reserved for intensive calibrations and preventative maintenance work on MAMu #1.

At 12:30 pm, MAMu #1 moved into the main lagoon area and set up near the vicinity of the outlet. Because of the light winds, the sampling hose and funnel were utilized and the funnel was positioned approximately 2 metres above the surface of the lagoon and 8 to 10 metres south of the main lagoon outlet - reference MP A122. Approximately 1.3 hours of ambient air data and two 30-minute GC samples were acquired at this site. For the common contaminants, significant concentrations of CO, TRS and TH-M were measured. The largest maximum 30-minute average (and overall mean) glc's of CO, TRS and TH-M were 7.75 (3.80), 0.069 (0.043) and 2.11 (1.75) ppm respectively. For the two GC samples, the total hydrocarbon loadings were 271 and 234 ug/m^3 with essentially equal contributions from the alkane and aromatic fractions (105 ug/m^3). The chlorinated species accounted for 8% of the total hydrocarbons and the area percent identified peaks were 34 and 16%. The average 1-isopropyl-4-methylbenzene and trichloromethane loadings were 27 and 9 ug/m^3.

After 2 pm, the TRS sampling train was again modified to measure COS and CS_2. With everything else remaining the same and commencing at 2:08 pm, approximately 0.7 hours of ambient air data were acquired in this mode of operation - reference MP A123. No GC sampling was performed after 1330 hrs. As noted in the results of MP A123, all concentrations for the common contaminants (apart from C_XS_X) remained essentially the same as those reported in MP A122. The C_XS_X glc's ranged from 0.006 to 0.021 ppm and the maximum 30-minute average glc was 0.016 ppm and the overall mean was 0.014 ppm. This suggests that at the exit of the lagoon, the COS and CS_2 concentrations now approached 33% of the total reduced sulphur compounds whereas at the inlet, these two compounds accounted for only 5%. These percentages are somewhat misleading since the measured concentrations of C_XS_X remained essentially the same during these two monitoring periods (i.e. 0.013 and 0.014 ppm) and the only variance was the TRS concentrations (0.267 at the inlet and 0.043 ppm at the exit). The sampling funnel was also positioned 2 metres above the lagoon surface for this latter measurement

At 2:45 pm, the scrubber was removed and the TRS analyzer was returned to its normal sampling mode - i.e. for the measurement of TRS. Just before 3:00 pm, the sampling funnel was positioned directly over the outlet, the TRS analyzer went off scale on its highest range - i.e. indicating TRS concentrations at the exit to be in excess of 12.5 ppm.

Because of the high ambient temperatures (in the high twenties) and the high TRS readings achieved during this last investigative period, purging and recalibration of the entire sampling train was needed. In order to accomplish this, MAMu #1 returned to the MNR site and a complete recheck and recalibration of the entire system was performed. Everything checked out fine and the MAMu #1 then prepared for overnight monitoring at this site - reference MP A124.

The acquisition of ambient air data commenced shortly after 4 pm. It should be noted that some residual TRS compounds remained in the sampling train until 7 pm (a maximum 30-minute average TRS glc c 0.006 ppm) but after that time, background levels or concentrations less than 0.001 ppm were measured. Similiarly, for all the other common contaminants, only low

or background concentrations were measured during this night. The instability of the air mass over Dryden increased as the morning approached. The ambient temperature and barometric pressure remained fairly constant overnight but the relative humidity increased dramatically (from 43% at 1600 hrs to 96% at 0600 hrs).

July 13

A low pressure area was located just south of the Manitoba boarder and was expected to pass through the Dryden area later today. Overcast stratacumulus and essentially calm wind conditions were present in the early morning.

Because of the weak and ill-defined wind pattern and the threatening weather, a light investigative work load was undertaken on this date and the investigation of emissions from the mill was deemed most probable on this date.

Since the mill plumes and other emissions were travelling aloft, MAMu #1 was positioned very close to the mill property. Just before 10 am, MAMu #1 sat up in the small park on the West River Road and just southeast of the main entrance to the mill - reference MP A132. Only one 30-minute GC sample and approximately 1 hour of ambient air data were acquired at this site. For the common contaminants, only low or near background concentrations levels were measured (the maximum 30-minute average TRS glc was only 0.006 ppm) and the total hydrocarbon loadings determined from the single GC sample was only 92 ug/m^3 with essentially equal contributions from the aromatic and alkane fractions (32 and 45 ug/m^3 respectively). The loading of 1-isopropyl-4-methylbenzene was 5.5 ug/m^3 and the area percent identified peaks was 55%.

An updated weather forecast just before noon called for thunderstorms and rain in the afternoon or early evening and since little success was being achieved at this site, MAMu #1 was then moved backed to the MNR site and placed on external power.

Monitoring at the MNR site was initiated at 12:30 pm and was allowed to continue till the following morning - reference MP A133. No thunderstorms developed but just before midnight, rain started and persisted till late morning. Low or near background levels for all of the common contaminants were measured overnight.

July 14

The low pressure area and its associated cold front pushed through Dryden during the early morning. Light rain was still prevelent until noon. The ambient temperature was in the mid to high teens and the winds were northwesterly and moderate (10 to 20 km/hr).

After calibration in the morning, a problem was noted with the GC and this day would be needed to rectify this situation. Nevertheless, ambient air data for the common contaminants was acquired on this date - off plant property and downwind of the mill and lagoon.

Just after 9 am, a strong sulphurous odour was detected by the MOE staff in the vicinity of Van Horne and Albert Streets. MAMu #1 moved to this locale and the acquisition of ambient air data commenced at 0929 hrs - reference MP A141. The winds were moderate and from 280 degrees magnetic. Emissions from the mill were impinging in this area. For the common contaminants, only significant glc's of TRS were measured. The maximum 30-minute average TRS glc was 0.014 ppm and the TRS concentrations decreased as the monitoring continued. At noon, the TRS had dropped below 0.002 ppm. Low concentration levels of TH-M were measured at this site. The maximum 30-minute average TH-M glc was only 0.42 ppm.

Just after 12 pm, MAMu #1 moved over to the clarifier road just off the Olson's Loading road and was positioned directly downwind of the main lagoon - reference MP A142. From the 3 hours of monitoring at this site, only the concentrations of TRS were found to be significant. For TRS, the maximum 30-minute average and overall average glc's were 0.013 ppm and 0.008 ppm respectively. The CO analyzer was inoperative and the maximum 30-minute average glc of TH-M was only 0.43 ppm.

After 3:30 pm, MAMu #1 returned to the MNR site and set up for overnight monitoring. Work continued on the GC and CO analyzers. The acquisition of ambient air data commenced at 4:37 pm and once again, no significant concentrations for any of the measured common contaminants were monitored reference MP A143.

July 15

The low pressure system had pushed north into the James Bay area by early morning and its cold front ran southwesterly through Lake Huron. The air mass over Dryden was still moist and unstable (light rain showers were reported at noon) and the sky condition was essentially scattered to broken cumulus. The winds veered from westerly to northerly as the day evolved and they were brisk (20 km/hr or greater).

At 9:00 am, a strong sulphurous odour was detected by the MOE staff at the Dryden Community Cente at Whyte and Arthur Streets. The malfunctions had been rectified on the GC and CO analyzers. After calibration, MAMu #1 moved over to this site-reference MP A152. The acquisition of data commenced just before 10 am and one hour of ambient air data and one 30-minute GC sample were acquired. Significant concentrations of CO, TRS and TH-M were measured at this site - the maximum 30-minute average glc's of CO, TRS and TH-M were 1.90, 0.022 and 0.85 ppm respectively. For the GC sample, the total hydrocarbon loading was 101 ug/m^3 with the alkane fraction comprising 38 % of this loading, the aromatic fraction 45% and the chlorinated fraction 7%. The 1-isopropyl-4-methylbenzene loading was 27 ug/m^3. The winds were veering and increasing in speed throughout this monitoring period. Initially MAMu #1 was directly downwind of the mill but at the end of this monitoring period, the majority of the mill's emissions were impinging near the public dock area at the corner of Victoria Street and Riverview Drive.

MAMu #1 moved over to this second downwind site just after 11 am and while at this site, acquired approximately 2 hours of data on the common contaminants and two 30-minute GC samples - reference MP A153. The winds were still veering and by 1 pm, the emissions from the mill were starting to impinge and align themselves with the Wabigoon River. However, during this period, significant concentrations of CO and TRS were measured. The maximum 30-minute average and overall mean glc of CO were 1.08 and 0.83 ppm and for TRS, they were 0.017 and 0.008 ppm respectively. The maximum 30-minute average glc of TH-M was only 0.51 ppm and the total hydrocarbon loadings from the 2 GC samples were 146 initially (between 11:12 and 11:42 am) and only 33 ug/m^3 finally (between 12:12 and 12:42 ppm). The 1-isopropyl-4-methyl benzene concentrations were similar in

both samples (23 and 21 ug/m^3) and it was by far the most dominant organic determined from these two samples.

Since the mill emissions were now impinging on the river and brisk northerly winds were present, an investigation of emissions from the lagoon was undertaken.

After 1 pm, MAMu #1 moved over to a site located approximately 100 metres west of Olson's Landing Road on Wilson's Road and was positioned directly downwind of the lagoon - reference MP A154. Commencing at 1:30 pm, approximately 3 hours of ambient air data and three 30-minute GC samples were acquired at this site. Because of the brisk winds (in excess of 20 km/hr), good dispersion was evident during this period, yet the 3 operators (i.e. MOE staff) did detect a relatively strong sulphurous odour and just after 3:30 pm, experienced slight eye irritations and stinging sensations. These physical effects may have been cumulative since only the concentrations of TRS were deemed to be significant (viz. the maximum 30-minute average was 0.016 ppm whereas all the other results were relatively low or at background levels - even the loadings of the GC samples). The average of the hydrocarbon loadings determined from the 3 GC samples was only 24 ug/m^3 with essentially equal contributions from the alkane and aromatic fractions and (7 and 13 ug/m^3 respectively).

It should be mentioned that although the reported GC loadings acquired at this site (A154) were low, the staff did experience some physical discomfort during this latter monitoring period. The resulting 3 chromatograms depicted no ambiguities nor unexplained peaks. The discomfort was real but the reason(s) behind it remains a mystery. Perhaps the cause could be a polar organic since the GC does not or could not detect any of these compounds - this, of course, is only speculative.

After 4 pm, MAMu #1 moved back the MNR site and commenced acquiring data for the overnight monitoring programme - reference MP A155. Further investigative work was undertaken on the GC system at this time and several calibrations were performed. All results were within specifications and the GC was prepared for the following day's sampling programme. For the common contaminants monitored overnight, only background concentrations levels were measured. The overall mean glc's of CO, TRS, TH-M and NO_x were 0.29, 0.001, 0.30 and 0.014 ppm respectively.

July 16

A high pressure area was now positioned over Dryden and the air mass was dry and stable. The sky cover was clear to light broken high cirrus and the winds were moderate (10 to 20 km/hr) and southwesterly. The dew point depression was in excess of 10°C and the ambient temperature was in the mid to high teens.

An investigation of the emissions from the lagoon was deemed most probable on this date. Two monitoring sites were selected - the first off plant property and downwind and the other, on plant property using the sampling hose and funnel.

After the morning calibration, MAMu #1 moved to a site approximately 300 metres west of Olson's Landing Road on Johnston Road - in front of the Smith's residence, north and directly downwind of the lagoon. Commencing at 10:18 am, approximately 2 hours of continuously monitored ambient air data and two 30-minute GC samples were acquired - reference MP A161. Some sulphurous odours were ascertainable at this site but the acquired data for the common contaminants revealed low or background concentration levels. The maximum 30-minute average glc's of TRS and TH-M were only 0.003 and 0.25 ppm respectively. Low concentrations were also depicted in the GC results. From the 2 samples, the total hydrocarbon loadings were only 40 and 18 ug/m^3.

Just after 12:00 pm, MAMu #1 moved over to the pump house area, on plant property and at the north edge of the lagoon. A lot of foam particulate was present at this site and because of this, the sampling hose and funnel (positioned approximately 5 metres above the lagoon surface) were utilized. Approximately 2 hours of continuously monitored data and only one 30-minute GC sample were acquired at this site. - reference MP A162. (After 1 pm, the GC system developed problems - a stuck valve that controls the cooling by liquid nitrogen - thus no more GC sampling could be undertaken after this time.) However, significant concentrations of TRS and TH-M were measured during this period. The maximum 30-minute

average and overall mean glc's of TRS were 0.017 and 0.016 ppm respectively and of TH-M, 1.37 and 1.34 ppm. All other concentration levels for the common contaminants were at or near background levels. For the GC sample, the total hydrocarbon loading was 248 ug/m^3 with the alkane, alkene, aromatic and chlorinated fractions being 145 (58%), 14 (6%), 58 (23%) and 23 (9%) ug/m^3 respectively. The trichloromethane loading was 14 ug/m^3, the 1-isopropyl-4-methylbenzene loading 7 ug/m^3 and the area percent identified peaks was 28%.

After 2:30 pm, MAMu #1 moved back to the MNR site where it was set up for overnight monitoring. Maintenance/repair work was also initiated on the GC. Because of this GC work, the overnight monitoring for the common contaminants did not commence until 5:30 pm - reference MP A163. Since the winds were southerly, this site could be considered as being upwind of both the mill and lagoon and all concentrations were expected to be at or near background levels. This was indeed the case - the overall mean glc's of TRS, CO, TH-M and NO_x were 0.001, 0.27, 0.33 and 0.014 ppm respectively.

July 17

The effects of the high pressure area still persisted over Dryden and the sky cover was scattered to broken cumulus and cirrus. The dew point depression was approximately 10°C and the temperature was in the mid to high twenties. The winds were calm initially but by early afternoon, they were light and southerly with a veering tend.

The monitoring programme for this date was to investigate emissions from the lagoon-on plant property monitoring.

After the morning calibrations, MAMu #1 was positioned near the spill barrier area at the lagoon - a site located approximately 80 m northwest of the main inlet. Commencing at 10:35 am, one hour of ambient air data and one 30-minute GC sample were acquired - reference MP A171. Apart from the non-methane hydrocarbons and the total reduced sulphur compounds, low concentrations were measured for the common contaminants. The maximum 30-minute average glc's reported for TRS was 0.008 ppm and for TH-M 2.71 ppm. From the GC sample, the total hydrocarbon loading was 266 ug/m^3 with an alkane fractional loading of 77 (29%), an aromatic loading of 154 (58%) and a chlorinated loading of 19 (7%) ug/m^3. The 1-isopropyl-4-methylbenzene loading was 124 ug/m^3 and the area percent identified peaks was 49%.

During this first monitoring period (i.e. A171), the ambient air was being sampled at approximately 5 metres above the surface of the lagoon. The sampling hose and funnel were then attached to the sampling inlet and the funnel was positioned just at the surface - these results are depicted by MP A172. Commencing at 11:34 am and using this latter sampling train, approximately 1.5 hours of ambient air data and two 30-minute GC samples were acquired. Very high concentrations of TRS and TH-M were measured whereas the concentrations for the oxides of nitrogen (the only other common contaminant monitored at this time) remained low. The overall mean and maximum 30-minute average glc's of TRS were 0.052 and 0.076 ppm and for TH-M, they were 15.03 and 26.85 ppm respectively. The total hydrocarbon loadings determined from the two GC samples were also

high - 500 and 2083 ug/m^3. The alkane fractions were 128 (26%) and 53 (3%) ug/m^3 respectively, the aromatic fractions were 302 (60%) and 1947 (93%) ug/m^3 and the chlorinated fractions were 48 (10%) and 81 (4%) ug/m^3. The 1-isopropyl-4-methylbenzene loadings were significant (228 and 1741 ug/m^3) and the area percent identified peaks were very low (29 and 15%).

Still maintaining this same sampling train, the TRS analyzer was then modified to measure COS and CS_2 (C_xS_x) - reference MP A173. Approximately 1.7 hours of ambient air data for the common comtaminants and one 30-minute GC sample were acquired during this period commencing at 1:18 pm. Again low concentrations of NO_x were measured; the concentrations of TH-M remained essentially the same (i.e. the maximum 30-minute average glc was 27.71 ppm and the overall mean glc was 15.45 ppm); and the concentrations for C_xS_x were essentially half of those reported for TRS (i.e. the overall mean (and maximum 30-minute average) glc of C_xS_x was 0.037 (0.046) ppm whereas for TRS, from the previous monitoring period, it was 0.076 (0.051) ppm). The results of the GC sample were expected to be similar to the first sets of results. This was indeed the case. The total hydrocarbon loading was 1284 ug/m^3 and the alkane loading was 117 ug/m^3 (9%), the aromatic loading 1084 ug/m^3 (84%) and the chlorinated 53 ug/m^3 (4%). The 1-isopropyl-4-methylbenzene loading was 868 ug/m^3 and again the area percent identified peaks was very low at 7%.

In order to verify that the C_xS_x concentrations were approximately 50% of the TRS results as acquired at this site and at this time, the TRS analyzer was next switched back to its normal monitoring mode - i.e. for the measurements of TRS At 3 pm, approximately 0.6 hours of ambient air data and another 30-minute GC sample were acquired at this site -reference MP A174. The overall average glc of TRS was 0.096 ppm and of TH-M, 28.43 ppm. The total hydrocarbon loading determined from the GC sample was 735 ug/m^3 with the alkane fractional loading of 123 ug/m^3 (17%) and the aromatic, 582 ug/m^3 (79%). The 1-isopropyl-4-methylbenzene loading was 274 ug/m^3 and once again, the area percent of identified peaks was very low at 10%.

After 3:30 pm, MAMu #1 was moved back to the MNR site where it was set up for overnight monitoring. As noted by monitoring period A175, this overnight monitoring commenced just before 4 pm and all reported concentrations of the common contaminants were at or near background levels.

July 18

A cold front pushed through overnight and light rain and fog persisted until noon in the Dryden area. The weather gradually improved and by late afternoon, the sky cover was scattered altocumulus. Significant easterly winds (in excess of 15 km/hr) were present on this date and this dictated the monitoring programme - an investigation, at sites west of the Wabigoon River, of the mill's gaseous emissions. The ambient temperature was in the mid to high teens.

During the morning calibrations, another problem developed with the GC and this day would be needed for its repair. Nevertheless, a monitoring programme was undertaken with the capability of only measuring the common contaminants.

In the morning the winds were northeasterly and after the completion of the morning calibrations at 10:30 am, MAMu #1 moved downwind of the mill and sat up at the corner of the West River and Aubry Roads - reference MP A182. One hour of ambient air data was acquired during MP A182 and from these results, only the glc's of TRS were deemed to be significant. A decrease in the TRS glc's was noted as time evolved during this monitoring period (due to the veering northeasterly winds) as initially, the maximum 30-minute average glc was 0.021 ppm whereas finally, this average was less than 0.001 ppm (i.e. less than the detectable limit of the TRS anlyzer).

Just before noon, the winds were east northeasterly and MAMu #1 moved to a site on Olson's Landing Road near the Woodland's parking lot - approximately 300 metres west southwest of the mill - reference MP A183. The winds were brisk (approaching 20 km/hr) and the dispersion conditions were good. Low concentrations were measured for the common contaminants. For example, from the 1.8 hours of acquired data, the maximum 30-minute average glc's of TRS was only 0.004 ppm and for TH-M, 0.27 ppm.

Around 1:30 pm, a slightly stronger sulphurous odour was noted approximately 100 metres further north of this site on Olson's Landing Road. MAMu #1 moved north to this site and starting just before 2 pm, collected another 2 hours of ambient air data on the common contaminants -reference MP A184. Once again, because of the good dispersion conditions and the veering wind, reasonably low concentrations of the common comtaminants were measured. The maximum 30-minute average and overall mean glc's of TRS were 0.014 and 0.006 ppm respectively and of TH-M, 0.23 and 0.16 ppm respectively.

After 4 pm, MAMu #1 moved back to the MNR site for overnight monitoring - reference MP A185. The winds continued veering throughout the night. Initially only background concentrations were measured for the common contaminants but by 4 am, the winds had become westerly and brisk (in the 15 km/hr range) and some TRS was measured at this site. The maximum 30-minute average TRS glc measured was 0.003 ppm and this reading was recorded at approximately 5:30 am. Low values were detected for the other contaminants.

July 19

The air mass was dry and stable behind the cold frontal passage on the 18th. The sky condition was clear to light broken cumulus and altocumulus. The winds were very strong (up to 40 km/hr for a 30-minute average) and northwesterly. The dew point depression was greater than 15°C and the temperature was in the low twenties.

Because of the winds and the approach of the end of this survey, a final investigation of emissions from the lagoon was undertaken on this date.

After the morning calibration, MAMu #1 moved to the main dock area of the lagoon. The air sampling inlet was located approximately 5 metres above the surface and starting at 10:49 am, approximately 2 hours of common contaminant data and one 30-minute GC sample were acquired - reference MP A192. For the common contaminants, only the concentrations of TRS were deemed to be signficant. The maximum 30-minute average and overall average TRS glc's were 0.033 ppm and 0.029 ppm respectively. Since the measured concentrations of TH-M were low (the maximum 30-minute average glc was only 0.37 ug/m^3), the loading of the GC sample was also expected to be low. This was indeed the case. The total hydrocarbon loading was only 63 ug/m^3 with the alkanes comprising 10% (6 ug/m^3) of this total, the aromatics 57% (36 ug/m^3) and the chlorinated 30% (19 ug/m^3). The 1-isopropyl-4-methylbenzne and trichloromethane loadings were 21 and 19 ug/m^3 respectively.

Just before 1 pm, the funnel and hose were attached to the sampling train and the funnel was placed at the lagoon surface - reference MP A193. Approximately 1.3 hours of ambient air data on the common contaminants and two 30-minute GC samples were acquired utilizing this sampling technique. For the common contaminants, significant concentrations of TRS and TH-M were measured. The maximum 30-minute average and overall mean glc's for TRS were 0.045 and 0.042 ppm respectively and for TH-M, they were 1.58 and 1.41 ppm respectively. The total hydrocarbon loadings determined from the two GC samples were 454 and 246 ug/m^3 with the alkane loadings accounting for 15% (i.e. 76 and 27 ug/m^3) of these totals on the average, the aromatic fractions 29% (103 and 97 ug/^{3}) and the

chlorinated organics 47% (214 and 117 ug/m^3). The trichloromethane loadings were 196 and 117 ug/m^3 and the 1-isopropyl-4-methylbenzene loadings were 62 and 69 ug/m^3.

After 2:20 pm, the sampling mode of the TRS analyzer was switched to C_XS_X (i.e. for the measurement of COS and CS_2). Using the same sampling train as described for MP A193 and starting at 2:26 pm, one hour of data for the common contaminants and one 30-minute GC sample were acquired - reference MP A194. The C_XS_X concentrations were now in the 0.008 ppm range whereas the TH-M glc's remained essentially the same (i.e., the maximum 30-minute average glc of C_XS_X was 0.008 ppm and for TH-M, 1.32 ppm). The GC sample depicted slightly lighter loadings than the first sample collected during the day at a height of 5 metres above the surface. The total hydrocarbon loading was only 59 ug/m^3 with the alkanes comprising 10% of this total, the aromatics 46% and chlorinated organics 32%. The trichloromethane and 1-isopropyl-4-methylbenzene loadings were 19 and 18 ug/m^3 respectively.

After 3:30 pm, the TRS analyzer was switched back to measure TRS concentrations and MAMu #1 was moved off plant property to a site at the junction of the clarifier road and Olson's Landing Road - directly downwind of the lagoon. Starting at 3:41 pm, 1.5 hours of common contaminant data and two GC samples were acquired at this site - reference MP A195. With respect to the common contaminants, only the resulting concentrations of TRS were considered significant. The overall average and maximum 30-minute average TRS glc's were 0.020 and 0.024 ppm respectively. With respect to the GC samples, the total hydrocarbon loadings were 78 and 105 ug/m^3 with the alkane fraction comprising 10% of these totals, the aromatics 36% and the chlorinated compounds 49%. The trichloromethane (and 1-isopropyl-4-methybenze) loadings were 18 and 42 ug/m^3 (22 and 29 ug/m^3). The area percent identified peaks were 26 and 42%.

Under these strong northwesterly winds, MAMu #1 next moved over to the Dryden Community Arena and Pool area - a site close to Earl Avenue and directly downwind of the main mill. MAMu #1 acquired one hour of ambient air data and one GC sample at this site commencing at 5:36 pm -

reference MP A196. Again for the common contaminants, only the glc's of TRS were deemed to be significant. The overall average and maximum 30-minute average glc's for this contaminant were 0.023 and 0.038 ppm respectively - i.e. the TRS Provisional Guideline was exceeded during this monitoring period. With respect to the GC sample, the total hydrocarbon loading was 74 ug/m^3 with the alkane fraction comprising 23% of this total, the aromatic fraction 42% and the chlorinated fraction 26%. The trichloromethane and 1-isopropyl-4-methylbenzene loadings were 10 and 22 ug/m^3 respectively and the area percent identified peaks was 27%.

After 6:30 pm, MAMu #1 moved back to the MNR site for overnight monitoring - reference MP A196. Apart from TRS, low or background concentrations were measured overnight for the common contaminants. Because of the westerly winds, some sulphurous odour was detected initially at this site and this is reflected by the TRS results. The maximum 30-minute average and overall average glc's of TRS were 0.007 and 0.002 ppm respectively.

July 20

Dryden was under the influence of a high pressure system. The air mass was dry and stable. The sky condition was clear to light broken cumulus and altocumulus. The dew point depression was in excess of 15°C and the ambient temperature was in the low twenties. The winds were westerly and moderate (10 to 20 km/hr).

This day would be reserved for monitoring emissions from the main mill.

After the morning calibrations, MAMu #1 moved back to the Dryden Community Arena and Pool area on Earl Avenue. Here, commencing at 10:47 am, approximately 3 hours of common contaminant data and four 30-minute GC samples were acquired - reference MP A201. The CO analyzer was inoperative and again, apart from the TRS results, all the other concentration levels for the common contaminants were low. The maximum 30-minute average and overall mean TRS glc's were 0.008 and 0.007 ppm respectively. The loadings determined from the 4 GC samples were also low. The total hydrocarbon loadings ranged from 55 to 130 ug/m^3 (a mean of 75 ug/m^3) and on the average, the alkane fraction comprised 44% of these loadings and the aromatics 45%. No chlorinated compounds were detected. The loadings of 1-isopropyl-4-methylbenzene ranged from 11 to 27 ug/m^3 (a mean of 20 ug/m^3) and the area per cent of identified peaks was high with an average of 72%. Sulphurous odours were detected by the staff at this site but just after 2 pm, problems developed in one of the electrical generators of MAMu #1. Thus the monitoring had to be terminated and MAMu #1 returned to the MNR site.

Once at the MNR site, maintenance work was performed on the generator and it was not until 4 pm that the unit was able to undertake overnight monitoring - reference MP A202. The CO analyzer was still inoperative and from the common contaminant results acquired overnight, only the concentrations of TRS were significant. Background concentrations of TRS were measured until 3 am when the winds picked up (10 to 20 km/hr) and became westerly. Between 3 and 6 am, the maximum 30-minute average TRS glc's ranged from .003 to 0.011 ppm. From the weather synopsis reported from the Dryden Airport, a low pressure system had pushed through Dryden around midnight and at 7 am, rain and fog with visibility at 5 miles were reported.

July 21

This was Sunday and the last monitoring day for the 85 Dryden ambient air survey.

After the passage of the low pressure system through Dryden overnight, the winds increased (in excess of 50 km/hr) and became northwesterly. The air mass was drying out and became more stable as the day evolved. A broken cumulus condition persisted throughout the day. The dew point depression was normally less than $10^{O}C$ and the temperature was in the mid teens.

A final investigation of emissions from the mill was undertaken on this date. After the morning calibration, MAMu #1 was moved to the public dock area at the corner of Victoria Street and Riverveiw Drive. Commencing at 10:20 am just under 3 hours of ambient air data for the common contaminants and three 30-minute GC samples were acquired at this site -reference MP A211. The MOE staff noted considerable downwash of the mill's main plumes and detected a sulphurous odour at this site. For the common contaminants, only the measurements of TRS resulted in appreciable concentrations. The overall average and maximum 30-minute average TRS glc's were 0.011 and 0.025 ppm respectively. At noon, problems developed with one of the electrical generators and the monitoring programme had to be terminated prematurely. Only the hydrocarbon analyzer (and later the oxides of nitrogen analyzer) was operational after this time and up until 1:10 pm - the final completion time of this monitoring period. The CO analyzer was not operational at all on this date. From the 3 GC samples, low hydrocarbon loadings were determined. The total hydrocarbon loadings ranged from 44 to 57 ug/m^3 (a mean of 49 ug/m^3) and on the average, the alkane fraction comprised 26% of these totals and the aromatics 57%. Some chlorinated hydrocarbons were detected only in the first sample (a total loading of 17 ug/m^3) and the 1-isopropyl-4-methylbenzene loadings were 15, 28 and 13 ug/m^3 for the 3 samples.

Because of the generator problem, MAMu #1 was pulled back to the MNR site and placed on shore-line power. Maintenance work was then performed on the generator and calibrations were run on the instruments. At 2:30 pm, only the TRS and NO_x anlayzers were on-line and the overnight monitoring programme commenced - reference MP A212. At midnight, some significant TRS concentrations were measured at this site. The maximum 60-minute average TRS concentration was 0.007 ppm.

On the morning of July 22nd, MAMu #1 left Dryden to undertake additional air quality surveys elsewhere in the Northwestern Region.

Interpretation of Results:

In this section, the discussion will first deal with general observations and findings regarding the survey as a whole and then the emphasis will be placed on the specific areas of interest as described in the introduction - i.e. the lagoon studies followed by the mill study, the fixed overnight monitoring at the MNR site and finally the Hi-Vol particulate findings.

MAMu #1 acquired approximately 314 hours of continuously monitored common contaminant data during 50 monitoring periods from Sunday July 6 to Monday morning July 22, 1985. This represented approximately 83% of the time that the monitoring unit was in Dryden. The remainder of the time was taken up by instrument calibrations, repairs, maintenance and logistical problems such as physically moving from one location to another and the supply of consumable goods (e.g. liquid nitrogen, CO_2, gases, etc.). A summary of the common contaminant measurements is presented in Table 13 on page 96. The results for each monitoring period are listed in the Appendix.

For the specific hydrocarbon or organic work, 61 1/2-hour GC samples were collected during the aforementioned monitoring periods and each was subsequently analyzed for over 120 compounds. The gas chromatograph analytical results are presented in Tables 8 to 12 on pages 85 to 95 in summary form grouped according to each aspect of the study. In these tables, the concentrations of some of the more significant compounds of the various organic groups are individually listed. Specifically, in the alkane series, Butane, Pentane, and Hexane are reported; for the aromatics, Toluene, Benzene, Xylene, and 1-isopropyl-4-methylbenzene (p-cymene) are reported; and from the chlorinated organic groups, trichloromethane (chloroform) is reported. All the results for each GC sample are presented in the appendix.

To determine particulate loadings in the vicinity of the lagoon, a 4-site network was employed and 46 Hi-Vol glass fibre filters were exposed.

1. **Lagoon Monitoring:**

Emissions from the lagoon are influenced by many factors. The sources of these emissions are the dissolved gases such as TRS, CO, NO_x etc. in the liquid effluent from the mill and the organic compounds which have been stripped from the wood fibres or modified by the process. Thus the factors that affect solubility and the liquid to gas or aerosol exchange at the surface will determine the emissions from the lagoon. Some of these factors are: the concentration and composition of the liquid; the degree of aggitation of the liquid by the aeration system, the inlet, and exit facilities; the amount of foam on the surface; wind speed; temperature; humidity; etc. Consequently the lagoon studies were conducted on different days and under different meteorological conditions.

A summary of the common pollutant measurements for the lagoon study is presented in Table 4. The 30-minute running averages are also presented graphically. Figure 6 (page 53) shows the data collected using the special inlet and funnel located less than 2 m above the surface of the lagoon. Figure 7 (page 54) shows the data collected at the edge of the lagoon using the standard inlet 5 m above the lagoon surface. Figure 8 (page 55) shows the results of sampling downwind of the main inlet to the lagoon as shown in the photograph of Figure 3b (page 8). Figure 9 (page 56) shows the results when the special C_xS_x scrubber was used with the TRS monitor and the sampling funnel was positioned less than 2 m above the surface of the lagoon. Figure 10 (page 57) shows the results of sampling downwind of the lagoon and off company property. The listings of the merged data sets which were used to create the graphs are also presented at the end of the Appendix.

Table 4 and these corresponding figures show that the most sigificant gaseous emissions from the lagoon were TRS and TH-M.

From the data acquired when the sampling port was positioned less than 2 metres above the lagoon surface, the maximum 30-minute average concentrations of TRS as determined during the four monitoring periods ranged from 0.045 to 0.098 ppm. During these four periods, the wind speeds ranged from calm to 30 km/hr. As noted from the merged data set for these periods the overall arithmetic mean TRS concentration was 0.051 ppm.

Table 4
Summary of Common Pollutant Measurements for the Lagoon Study

Monitor Period	Duration (hours)	Range of 30 min Wind Speed km/h	Range of 30 min. Wind Direction	Max. 30-minute Aver. Conc. (ppm)				Average Conc. for Period (ppm)				Location	Comments
				TRS	TH-M	CO	NO_x	TRS	TH-M	CO	NO_x		
a) Less than 2 m above Lagoon Surface													
A193	1.5	28.6-30.3	303-317°	0.045	1.58	0.47	0.01	0.042	1.41	0.41	0.01	Main Dock	Funnel 2 m above surf.
A122	1.3	1.7-3.5	35-150°	0.069	2.11	7.75	0.09	0.043	1.75	3.80	0.05	Lagoon Outlet	Funnel 2 m above surf.
A172	1.6	0.9-10.3	15-198°	0.076	26.85	-	0.02	0.052	15.03	-	0.01	Spill Barrier	Funnel 2 m above surf.
A174	0.6	10.0	216°	0.098	29.51	-	0.04	0.096	28.43	-	0.04	Spill Barrier	Funnel 2 m above surf.
Beside Main Inlet													
A113	1.1	26.9-31.5	266-276	0.539	2.73	0.75	0.01	0.267	2.39	0.67	0.01	Main Inlet	Funnel 2 m above surf.
Special Scrubber (For COS and CS_2)													
A114	2.3	12.8-25.8	258-280	0.017	2.47	0.65	0.01	0.013	2.19	0.59	0.01	Main Inlet	
A123	0.7	12.6-15.5	310-316	0.016	1.47	1.71	0.03	0.014	1.41	1.35	0.02	Lagoon Outlet	
A173	1.6	2.2-5.5	177-243	0.046	2.53	-	0.01	0.037	2.32	-	0.01	Spill Barrier	
A194	1.1	32.6-37.3	291-309	0.008	1.32	0.44	0.01	0.007	1.12	0.40	0.01	Main Dock	
b) 5 m Above Surface													
A112	1.8	18.8-23.5	275-290°	0.029	1.77	-	0.01	0.023	1.50	-	0.01	Main Dock	5 m above surface
A192	2.0	28.0-39.6	314-330°	0.033	0.37	1.48	0.01	0.029	0.35	0.54	0.01	Main Dock	5 m above surface
A171	0.9	4.7-6.5	119-152°	0.008	2.71	0.08	0.03	0.008	1.68	0.07	0.02	Spill Barrier	5 m above surface
A162	1.9	12.1-18.2	212-246°	0.017	1.66	0.37	0.01	0.016	1.40	0.26	0.01	Pump House	5 m above surface
c) Downwind - Off Company Property													
A073	1.7	7.8-11.3	115-172	0.009	0.08	0.80	0.01	0.005	0.07	0.69	0.01	Smith Resid.	300 m N of Lagoon
A161	2.0	7.4-17.8	159-243	0.003	0.25	0.14	0.01	0.003	0.21	0.09	0.01	Smith Resid.	300 m N of Lagoon
A142	2.7	8.2-24.4	277-331	0.013	0.43	-	0.03	0.008	0.27	-	0.01	Clarifier Rd.	100 m E of Lagoon
A195	1.7	34.7-41.1	298-304	0.024	0.51	1.37	0.01	0.020	0.46	0.77	0.01	Clarifier Rd.	100 m E of Lagoon
A154	2.6	21.3-24.7	337-346	0.011	0.29	0.74	0.03	0.010	0.27	0.48	0.01	Rissanen Resid.	175 m S of Lagoon
d) Upwind - Off Company Property													
A083	1.1	12.5-14.3	275-291	0.011	0.08	0.32	0.01	0.008	0.08	0.32	0.01	Hwy 17 & Marguerite Rd.	Downwind of Sewage Treatment Plant

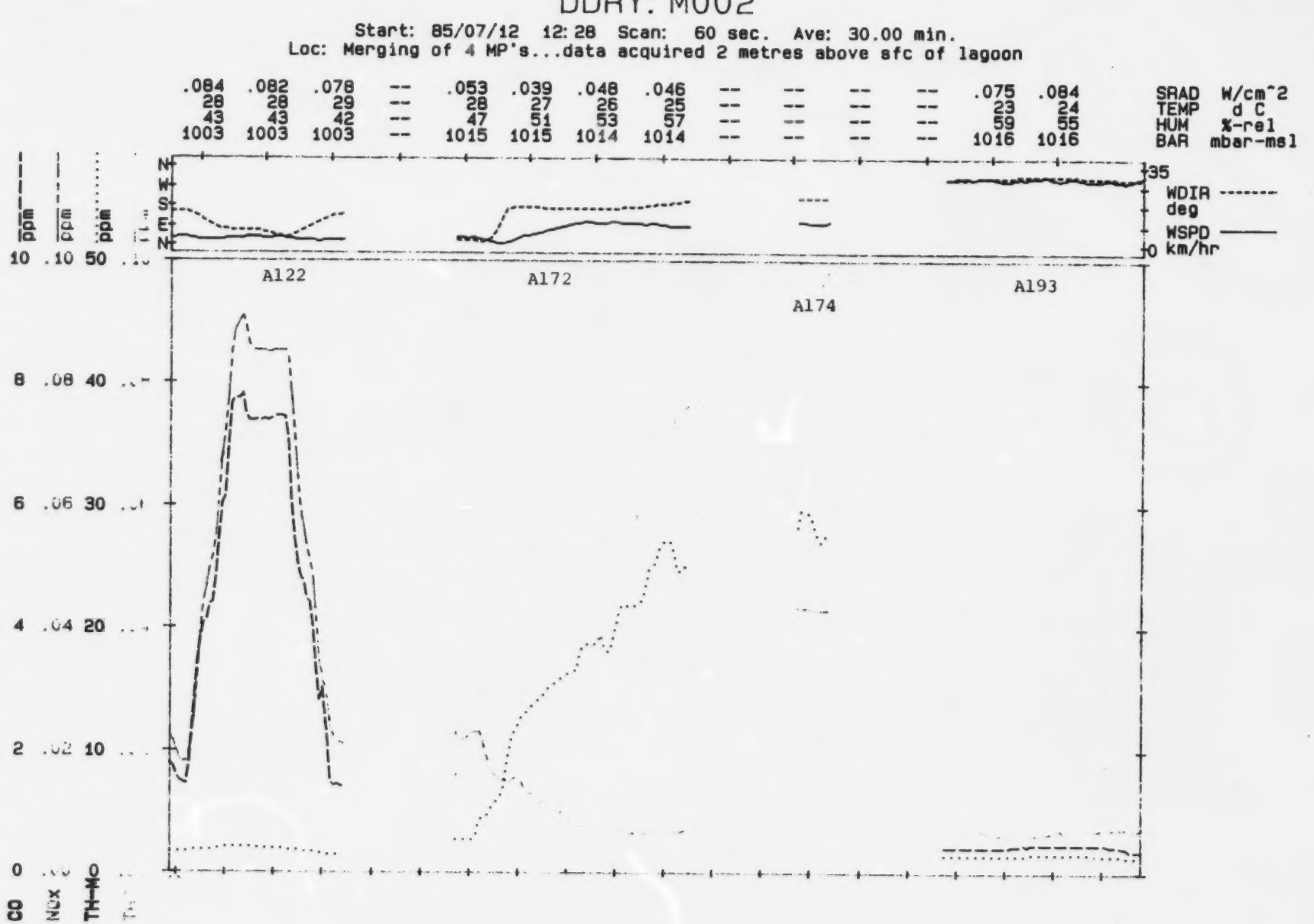

DDRY: M002
Start: 85/07/12 12:28 Scan: 60 sec. Ave: 30.00 min.
Loc: Merging of 4 MP's...data acquired 2 metres above sfc of lagoon
.084 .082 .078 -- .053 .039 .048 .046 -- -- -- -- .075 .084
28 28 29 -- 28 27 26 25 -- -- -- -- 23 24
43 43 42 -- 47 51 53 57 -- -- -- -- 59 55
1003 1003 1003 -- 1015 1015 1014 1014 -- -- -- -- 1016 1016
SRAD W/cm^2
TEMP d C
HUM %-rel
BAR mbar-msl
ppm
ppm
ppm
10 .10 50
8 .08 40
6 .06 30
4 .04 20
2 .02 10
0
CO
NOx
TH-HC
N
W
S
E
N
35
0
WDIR
deg
WSPD
km/hr
A122
A172
A174
A193

Figure 6

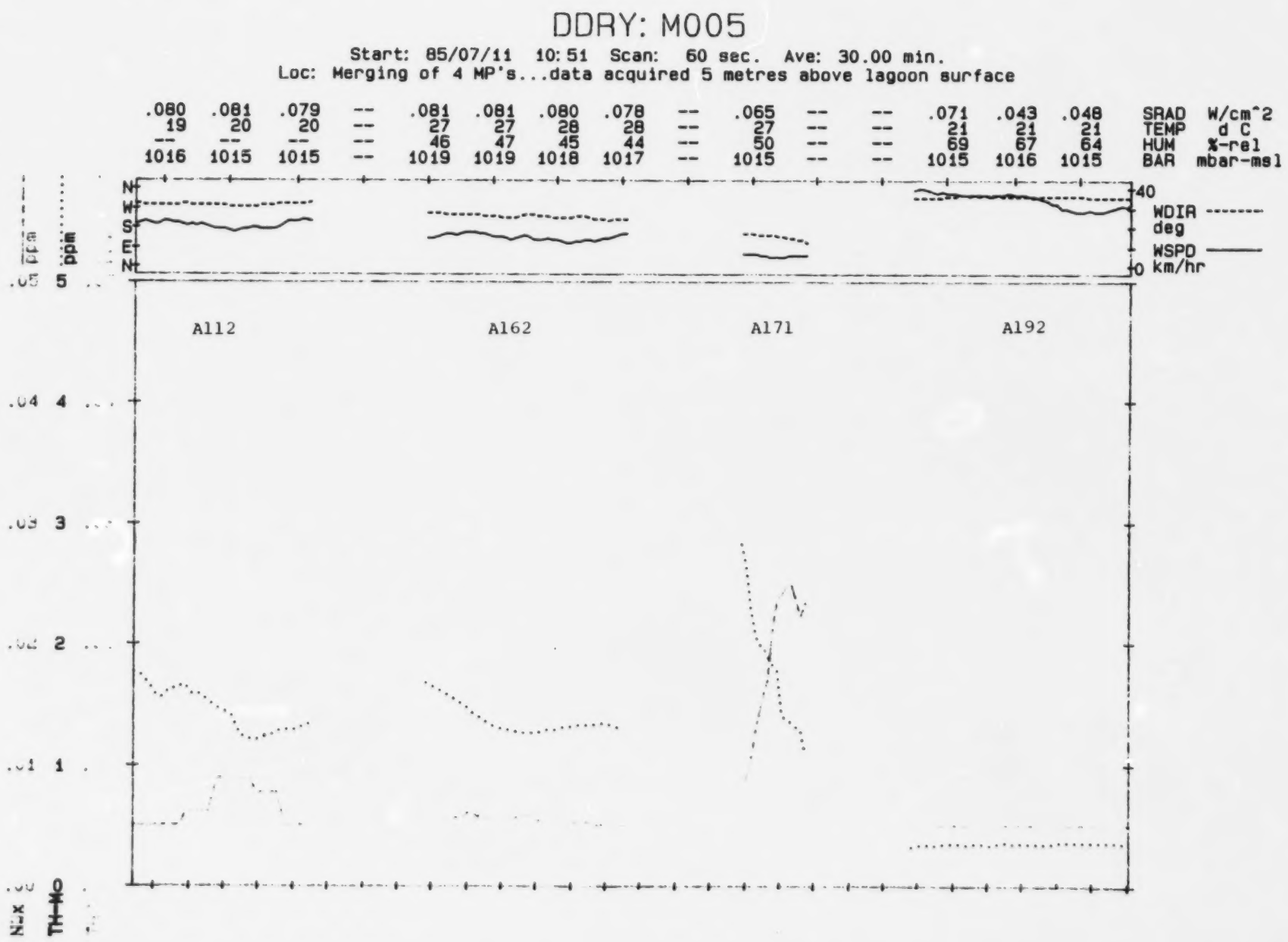

DDRY: M005
Start: 85/07/11 10:51 Scan: 60 sec. Ave: 30.00 min.
Loc: Merging of 4 MP's...data acquired 5 metres above lagoon surface
.080 .081 .079 -- .081 .081 .080 .078 -- .065 -- -- .071 .043 .048 SRAD W/cm^2
19 20 20 -- 27 27 28 28 -- 27 -- -- 21 21 21 TEMP d C
-- -- -- -- 46 47 45 44 -- 50 -- -- 69 67 64 HUM %-rel
1016 1015 1015 -- 1019 1019 1018 1017 -- 1015 -- -- 1015 1016 1015 BAR mbar-msl
N
W
S
E
N
40
WDIR
deg
WSPD
0 km/hr
ppm
5
4
3
2
1
0
A112
A162
A171
A192
NOx
THC

Figure 7

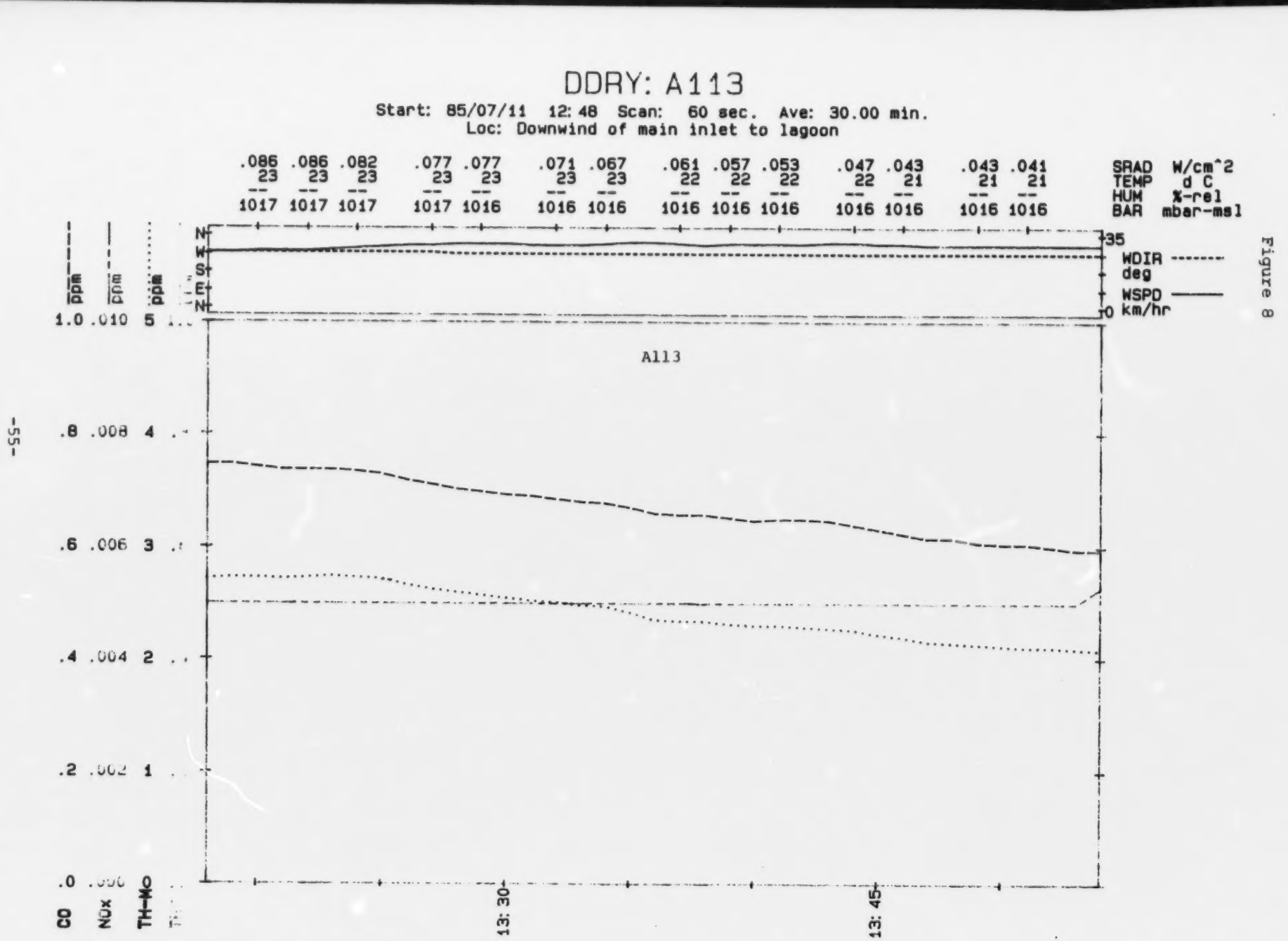

DDRY: A113
Start: 85/07/11 12:48 Scan: 60 sec. Ave: 30.00 min.
Loc: Downwind of main inlet to lagoon
.086 .086 .082 .077 .077 .071 .067 .061 .057 .053 .047 .043 .043 .041
23 23 23 23 23 23 23 22 22 22 22 21 21 21
1017 1017 1017 1017 1016 1016 1016 1016 1016 1016 1016 1016 1016 1016
SRAD W/cm^2
TEMP d C
HUM %-rel
BAR mbar-msl
ppm ppm ppm
1.0 .010 5
.8 .008 4
.6 .006 3
.4 .004 2
.2 .002 1
.0 .000
CO NOx TH-HC
N W S E N
35
0 km/h
WDIR
deg
WSPD
A113
13:30
13:45

Figure 8

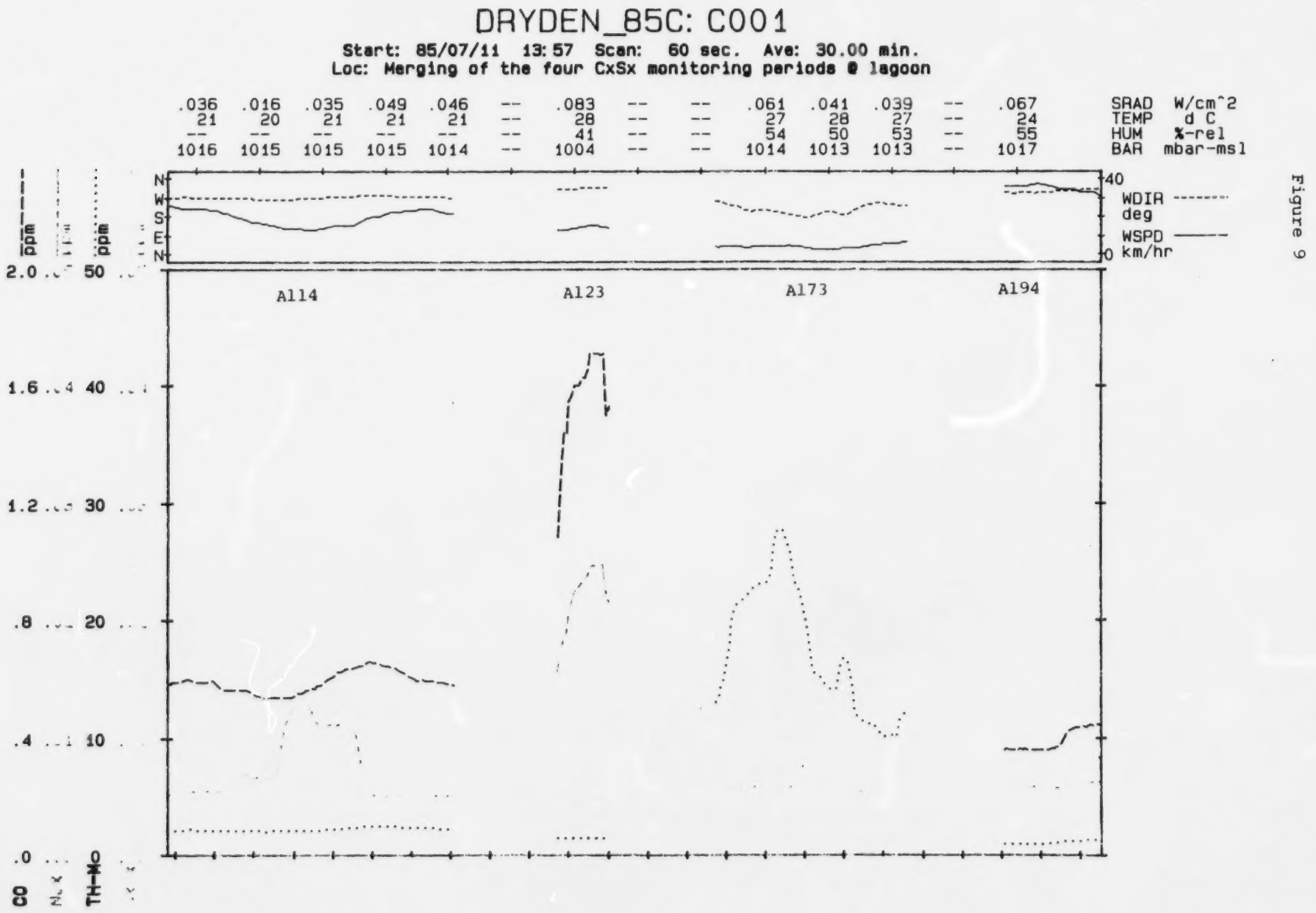

DRYDEN_85C: C001
Start: 85/07/11 13:57 Scan: 60 sec. Ave: 30.00 min.
Loc: Merging of the four CxSx monitoring periods @ lagoon
.036 .016 .035 .049 .046 -- .083 -- -- .061 .041 .039 -- .067
21 20 21 21 21 -- 28 -- -- 27 28 27 -- 24
-- -- -- -- -- -- 41 -- -- 54 50 53 -- 55
1016 1015 1015 1015 1014 -- 1004 -- -- 1014 1013 1013 -- 1017
SRAD W/cm^2
TEMP d C
HUM %-rel
BAR mbar-msl
N
W
S
E
N
40
WDIR
deg
WSPD
0 km/hr
ppm
ppm
2.0
50
1.6
40
1.2
30
.8
20
.4
10
.0
0
A114
A123
A173
A194
CO
TH-NO

Figure 9

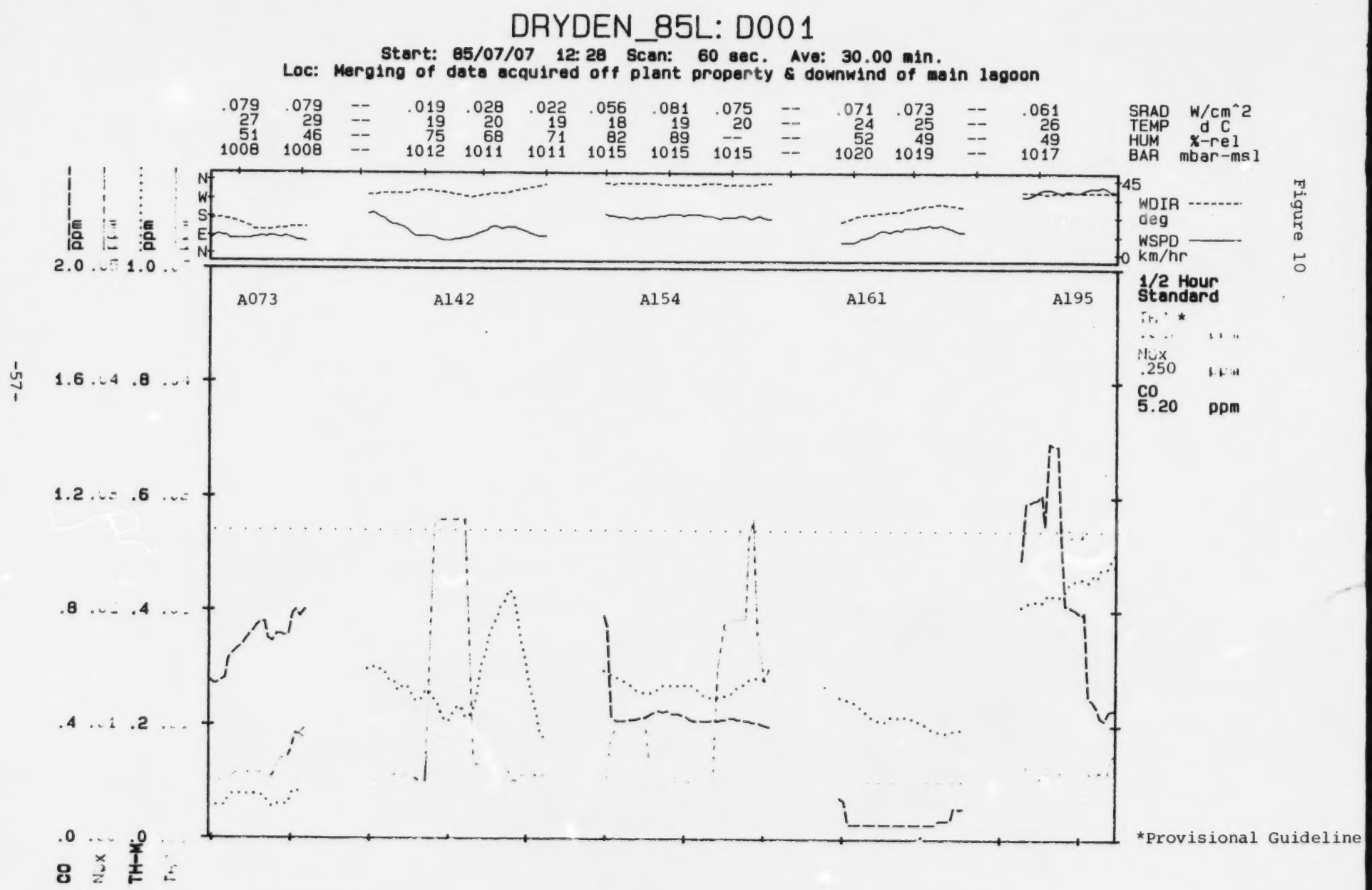

DRYDEN_85L: D001
Start: 85/07/07 12:28 Scan: 60 sec. Ave: 30.00 min.
Loc: Merging of data acquired off plant property & downwind of main lagoon
.079 .079 -- .019 .028 .022 .056 .081 .075 -- .071 .073 -- .061
27 29 -- 19 20 19 18 19 20 -- 24 25 -- 26
51 46 -- 75 68 71 82 89 -- -- 52 49 -- 49
1008 1008 -- 1012 1011 1011 1015 1015 1015 -- 1020 1019 -- 1017
SRAD W/cm^2
TEMP d C
HUM %-rel
BAR mbar-msl
N
W
S
E
N
45
0
WDIR
deg
WSPD
km/hr
A073
A142
A154
A161
A195
1/2 Hour
Standard
NOx
.250
CO
5.20 ppm
2.0
1.0
1.6
1.2
.8
.4
.0
CO
NOx
TH-HC
*Provisional Guideline

Figure 10

In the normal air sampling mode (i.e. the sampling port located 5 metres above the surface), the TRS concentrations were found to be lower. Again from Table 4, the maximum 30-minute average TRS concentrations now varied from 0.008 to 0.033 ppm. Four monitoring periods also comprised this sampling technique and from the merged analyses of the data acquired during these periods (Figure 7), the overall arithmetic mean concentration of TRS was determined to be 0.021 ppm -a concentration slightly less than 50% of the surface concentrations presented.

The highest concentrations of TRS were measured at the inlet and exit channels of the lagoon. For the inlet measurements, the sampling port was located near the surface and immediately downwind of the surface turbulence where the clarifer effluent entered the aeration basin -see Figure 3b. During this measurement the maximum 30-minute average TRS concentration was determined to be 0.539 ppm. When the sampling funnel (port) was placed over the outlet spillway, the TRS analyzer went "off scale". This indicated TRS concentrations to be in excess of 12.5 ppm.

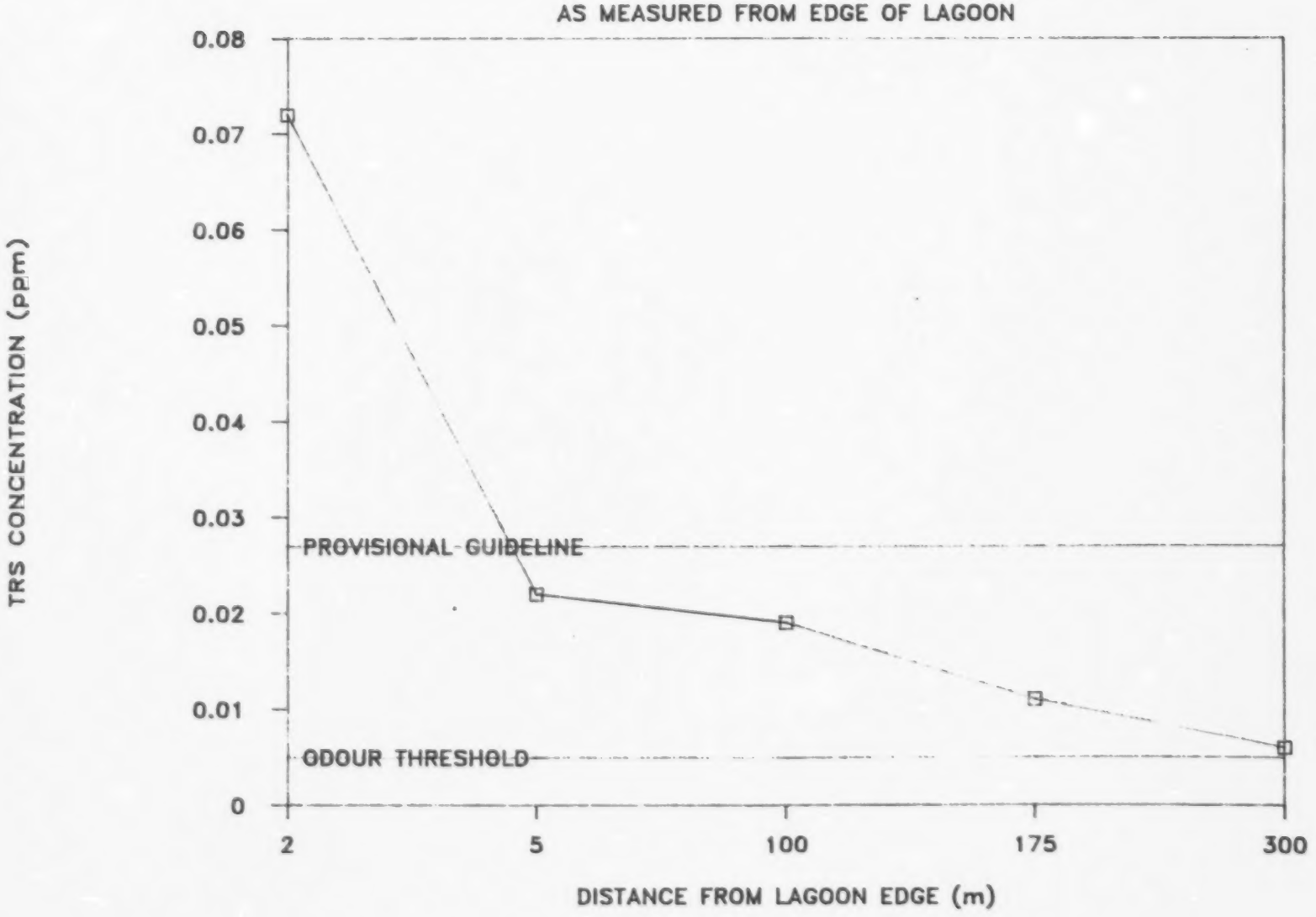
To complete the discussion of TRS investigations at the lagoon, the results of the tests using the special scrubber with the TRS analyzer in order to measure carbonylsulphide (COS) and carbon disulphide (CS_2) will now be presented. It should be mentioned that more development work is being done on this system and at the time of this survey, the conversion efficiency was estimated to be over 95%. Under steady state conditions of relatively high TRS concentrations (i.e. the lagoon monitoring) a reasonable field test of this system was undertaken. From the four monitoring periods during which C_xS_x (i.e. COS and CS_2) was measured, the maximum 30-minute average cocentrations were 0.008 (main dock area), 0.016 (outlet area), 0.017 (inlet area) and 0.046 ppm (spill barrier). Immediately before, the maximum 30-minute TRS average concentrations measured at these sites were 0.045 (main dock), 0.069 (outlet), 0.539 (inlet) and 0.076 ppm (spill barrier). Thus although the TRS concentrations varied considerably (i.e. the range was 0.045 to 0.538 ppm), the C_xS_x concentrations remained essentially uniform (i.e. the range being 0.008 to 0.046 ppm). Thus it appears that the C_xS_x concentrations remained fairly consistent throughout the lagoon whereas the other TRS compounds underwent some degradation (note: at the inlet, the TRS concentration was 0.539 ppm whereas at the outlet, it was only 0.069 ppm).

The aforementioned TRS studies were carried out "on-plant property" at the lagoon. In the following TRS discussions, the findings were acquired "off-plant property" and thus the Environmental TRS Provisional Guideline of 0.027 ppm should be applicable.

Using normal sampling techniques (i.e. the sampling port located atop the monitoring unit and 5 metres above the surface), the TRS concentrations were found to decrease considerably with increasing downwind distances from the lagoon. Five monitoring periods constituted this part of the lagoon study and measurements were taken at distances ranging from 100 to 300 metres from the nearest edge of the lagoon. From these 5 monitoring periods, the maximum 30-minute average glc's of TRS ranged from 0.024 to 0.003 ppm. These findings are presented graphically in Figure 10 (page 57). The data from these monitoring periods were then merged and the resulting overall arithmetic mean TRS concentration was 0.009 ppm. Thus the TRS concentrations as determined at the downwind off property sites did not exceed the Provisional Guideline. However, the nominal TRS odour threshold of 0.005 ppm was exceeded during all 5 monitoring periods and for four of these periods, the maximum 30-minute average concentrations exceeded this odour threshold level as well. Hence, malodourous TRS emissions would be perceived at the nearby residences during periods when they were downwind of this lagoon. (Refer to Figure 11).

The other gaseous contaminants at the lagoon were the hydrocarbons. The non-methane hydrocarbons (TH-M) results are also presented in Table 4 and Figures 6 through 10 (pages 52 to 57). There are no applicable Standards, Criteria nor Guidelines for these measurements but rather they were used as quantative real-time measurements for the GC sampling programme. In general, the highest concentrations were measured at less than 2 metres above the lagoon surface but depending on the location, the maximum 30-minute average concentrations varied considerably - i.e. from 1.32 ppm (MP A194 at the main dock area) to 29.51 ppm (MP A174 at the spill barrier). From the sampling performed at the 5 metre height above the lagoon surface, the maximum 30-minute average concentrations ranged from 0.37 ppm (at the main dock area) to 2.71 ppm (at the spill barrier). For off plant property and farther downwind monitoring, the concentrations of TH-M drooped off

FIGURE 11 MEAN TRS CONCENTRATIONS



considerably. At 100 metres downwind from the lagoon, the average maximum 30-minute average TH-M concentration was 0.47 ppm; at 175 metres downwind 0.29 ppm; and at 300 metres downwind 0.17 ppm. Thus the non-methane hydrocarbon concentrations were low, but measurable at the neighbouring residences.

Lagoon - GC results:

For reference, a summary of the pertinent GC work performed at the lagoon is presented in Table 5 on the following page.

a) **On Plant Property**

Seventeen 30-minute GC samples were acquired on plant property. On the average, the total hydrocarbon loadings determined from these samples ranged from 219 ug/m^3 (at 5 metres above the surface) to 652 ug/m^3 (at distances less than 2 metres above the surface). The alkene fractions were very low (less than 10 ug/m^3) and consistant, thus serving as a measure of the integrity in the sampling/analytical techniques employed. In addition, this integrity is also evident from the simple alkane contributions (i.e. butane, pentane and hexane) and the BTX's (benzene, toluene and xylenes) - both of these sub-groupings having concentrations less than 40 ug/m^3 total.

The largest variant in the total hydrocarbon loadings was caused by the aromatic fraction - on the average, loadings ranged from 82 ug/m^3 (37% at 5 metres above the surface) to 483 ug/m^3 (74% at distances less than 2 metes above the surface).

Table 5
Summary of Gas Chromatography Analytical Results

	2m Above Surface	Inlet to Lagoon	5m Above Lagoon	100m Downwind of Lagoon	175m Downwind of Lagoon	300m Downwind of Lagoon	Upwind	Downtown Toronto	Downwind of Mill
Total Hydrocarbon Loadings	652	413	219	99	24	34	64	323	88
Alkanes	83	118	87	10	7	18	37	200	35
Alkenes	7	4	9	4	2	6	7	22	7
Aromatics	483	120	82	33	14	11	18	72	40
Chlorinated Aromatics	72	164	34	45	-	-	-	N/A	8
Butane	11	2	18	3	2	4	6	39	9
Pentane	7	34	9	3	1	1	3	23	4
Hexane	4	2	4	1	-	1	2	12	2
Toluene	8	2	3	2	1	1	1	18	3
Benzene	11	3	4	4	2	3	5	13	5
Xylenes	13	3	4	-	1	1	2	15	3
Trichloromethane	57	141	17	30	-	-	-	-	6
1-isopropyl-4-methylbenzene	368	80	39	26	10	4	6	N/A	25
Area % Identified Peaks	28	32	35	34	58	54	58	70-80	61
Number of Samples	9	3	5	2	3	5	3	12	31

N/A = Not Available

By far, the most dominant aromatic detected in these samples was 1-isopropyl-4-methylbenzene at loadings, on the average as taken from Table 5, of 39 to 368 ug/m^3. From discrete samples, the maximum loading was 1741 ug/m^3 and was detected during MP A172 - this loading accounted for 84% of the total hydrocarbon loading and 89% of the aromatic loading.

Some conditioning statements have to be made with respect to this organic and its reported amounts. First, a Nafion membrane drier was used with the GC in order to dry the acquired samples, to eliminate the freeze-up in the pre-focusing loops and to reduce water-related retention time variations as the constituents of the sample eluted from the fused-silica columns. This drier was necessary since prefocussing loop freeze-up and retention time variabilities complicates indentification and quantification of compounds and thus would render the field GC libraries useless. Secondly, and as noted by W.F. Burns et al. (Journal of Chromatography 269 (1983) I 9), the Nafion membrane drier causes rearrangment of several mono-terpenes and removes several important oxygenated and polar compounds from the samples. With respect to the latter half of this statement, the Nafion drier employes a diffusion technique which essentially removes not only water but most polar compounds such as amines, ketones, alcohols, some ether and reduced sulphur compounds. Now with respect to the first part of the above statement, a synonym for 1-isopropyl-4-methylbenzene is paracymene or p-cymene. This organic is one of the minor products of the wood pulp sulphite process and probably results as a break-down product of terpenes that are present in the wood. As stated in the aforementioned paper, p-cymene itself was unaffected by the Nafion drier but was also the largest end product resulting from the rearrangement of the mono-terpenes caused by this drier. In other words, because the gasesous emissions from the lagoon contained some mono-terpenes (as identified by GC/MS analyses of additional samples), the loadings of 1-isopropyl-4-methylbenzene (p-cymene) would be elevated and the cause of these elevations would be the addition of unknown quantities of rearrangeed mono-terpenes.

P-cymene is found in nearly 100 volatile oils including lemongrass, sage, thyme, coriander, star anise, and cinnamon. Other information on p-cymene (E.E. Sandmeyer's contribution to Patty's Industrial Hygiene and Toxicology handbook by J.W. Wiley and Sons of New York) states that "this organic is capable of serving as a carbon source for several strains of pseudomonas dismolytica-like microbacteria under the production of cumic acid. " and that the toxicity of p-cymene - i.e. its physiologic response is that it"... appears slightly less toxic than the n-propyl isomer of cumene but more toxic than benzene or toluene. Like its lower homologues, it may be an irritant to the eyes and skin. " and " Prolonged skin contact may result in skin rashes."

The Ministry does not have any Standards, Criteria or Guidelines for 1-isopropyl-4-methylbenzene. From E.E. Sandmeyer's article humans may experience an irritation if by inhalation, the concentrations approach 200 ppm (i.e. a mass loading of 1 gram/m^3). In our survey around the lagoon the maximum loading was 1,741 ug/m^3 or 0.2% of the above value and the maximum average loading was 368 ug/m^3.

For the alkane contributions to the total hydrocarbon loadings determined at the lagoon, the quantities were fairly uniform - i.e. the range was, on the average, from 83 to 118 ug/m^3 and depending on the total loadings, accounted for 13 to 40% of these loadings.

The concentrations of chlorinated organics were somewhat dependent on the sampling location. On the average, downwind of the inlet, the total chlorinated organic loading was 164 ug/m^3; at less than 2 metres above the surface, the loading was 72 ug/m^3; and at 5 metres, the loading was 34 ug/m^3. By far, the most dominant chlorinated organic detected was trichloromethane or also known as chloroform. With respect to the individudal samples, the largest chloroform loading detected was 196 ug/m^3 and this sample was acquired during MP A193 at a site near the dock area with the sampling port located just above the lagoon surface. Although not applicable in this case since this measurement was obtained on plant property, the Environmental 1/2-hour Guideline for this contaminant is 1,500 ug/m^3.

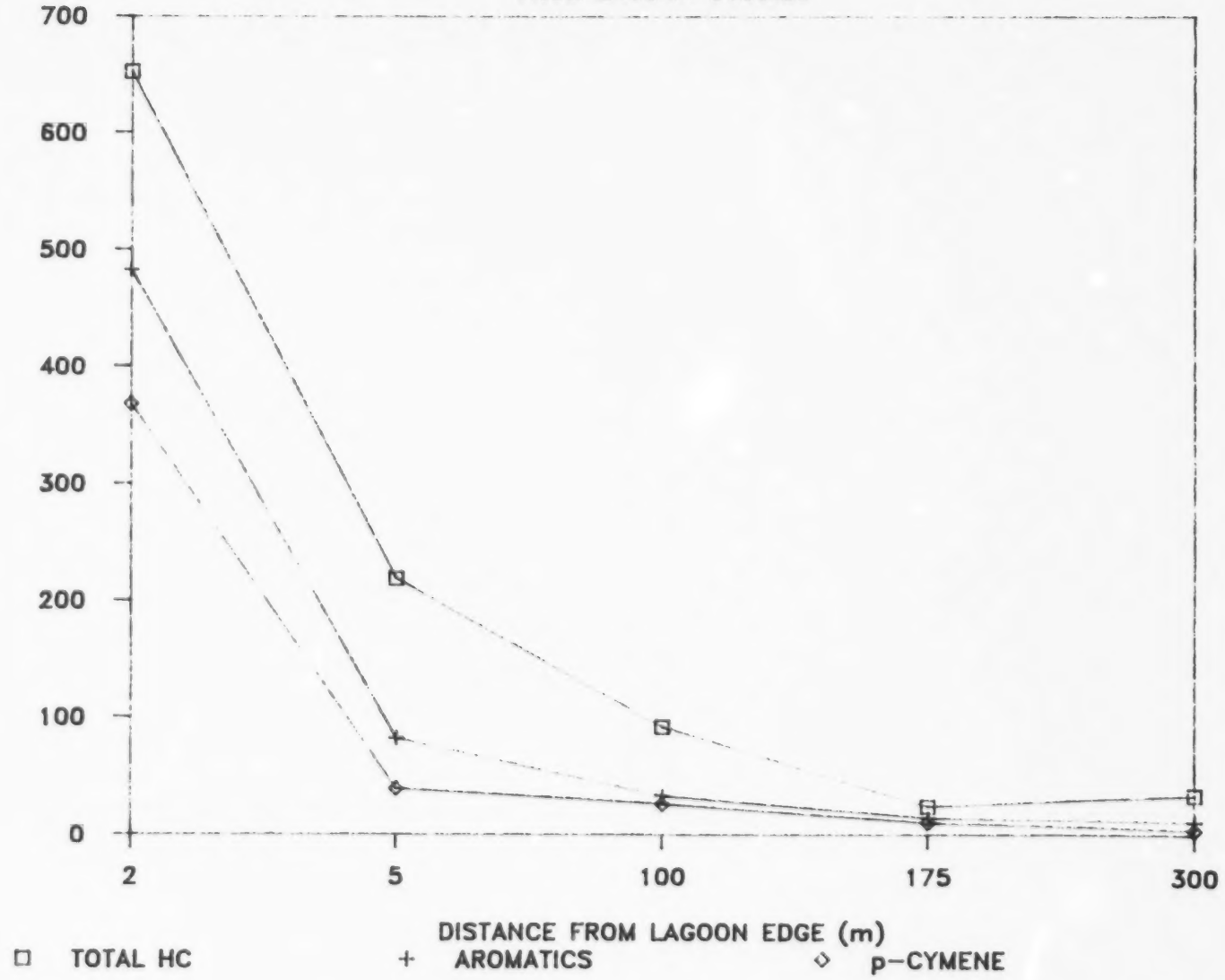
b) **GC Data off Plant Property**

The non-methane hydrocarbon and the total hydrocarbon loadings decreased considerably as the downwind distance increased. From the 10 acquired GC samples (see Table 5), only background concentrations were measured and no chlorinated organics were detected at downwind distances of 175 metres or greater. On the average, at 100 metres downwind, the total hydrocarbon loading was 92 ug/m^3 whereas at 175 metres, it was only 24 ug/m^3 and at 300 metres, 34 ug/m^3. At 100 metres, the chloroform and p-cymene loadings were only, on the average, 30 and 26 ug/m^3 respectively (Refer to Figure 12).

Finally, for the GC samples acquired downwind of the lagoon, the success of identifying all the organic compounds depicted by the resulting chromatograms is reflected by the area percent identified peak figures. For the on-site samples, these percentages were approximately 32%. At 100 metres downwind, this percentage was still in the mid thirties but at 175 metres and greater, these percentages were in the high 50% range. The reason for this difference is that for the lagoon and samples acquired within 100 metres downwind, the terpene-based organics dominated the chromatograms and the closeness of these compounds with respect to retention indices, made the positive identification and quantification of these higher ordered organics impossible. At downwind distances of 175 metres and greater, the influence of these terpenes was not as pronounced.

FIGURE 12 TOTAL HC & SELECTED ORGANICS

FROM LAGOON STUDIES



2. Mill Monitoring:

At the time of this survey, total reduced sulphur (TRS) compounds were the major contaminants of interest to be measured downwind of the complex. Sixteen monitoring periods constituted this downwind monitoring programme. Approximately 36 hours of continuously monitored data were acquired for the common contaminants and 31 30-minute GC samples were acquired for the identification of organic compounds (see Table 1b).

Since TRS was the major contaminant of interest, the major source in the mill complex for this contaminant was the recovery boiler. The in-stack theoretical calculated emission concentration originating from this source required to satisfy the Provincial point of impingement Guideline of 0.027 ppm TRS is 160 ppm. From stack measurements of TRS (as supplied by Great Lakes Forest Products Ltd. and as shown in Table 6, this concentration level was exceeded on July 7, 11, 12 and 18th.

From the merged data for these 16 monitoring periods (Figure 13), it was immediately obvious that indeed for the common contaminants, TRS concentrations depicted a great deal of variability and was the contamiant of major interest whereas for the others, the reported concentrations were at or near background levels. As noted in the graphical display of this merged data set, the TRS Provisional Guideline was exceeded during 4 of these periods and under closer inspection, during MP A102 at the first little park on the West River Road in front of the mill, the largest 30-minute maximum average glc of TRS was recorded for this survey; this value being 0.154 ppm or over 5 times the Guideline. The other 3 monitoring periods took place at sites that could be considered as being in the residential and commercial areas of Dryden - one at the Community Centre (A196) and two at the public dock area at Victoria and Riverview (A091 and A103). At these sites, the TRS maximum 30-minute average glc's were 0.038 (A196), 0.072 (A091) and 0.039 ppm (A103).

Table 6

Average Daily TRS Emissions From Recovery Boiler Stack

Date July 1985	Average Daily TRS Emission (ppm)
1	-
2	-
3	-
4	140
5	120
6	150
7	195
8	120
9	90
10	120
11	210
12	165
13	150
14	150
15	120
16	150
17	- Plugged Furnace
18	180
19	105
20	130
21	30
22	45
23	60
24	60
25	60
26	15
27	30
28	30
29	40
30	30
31	40

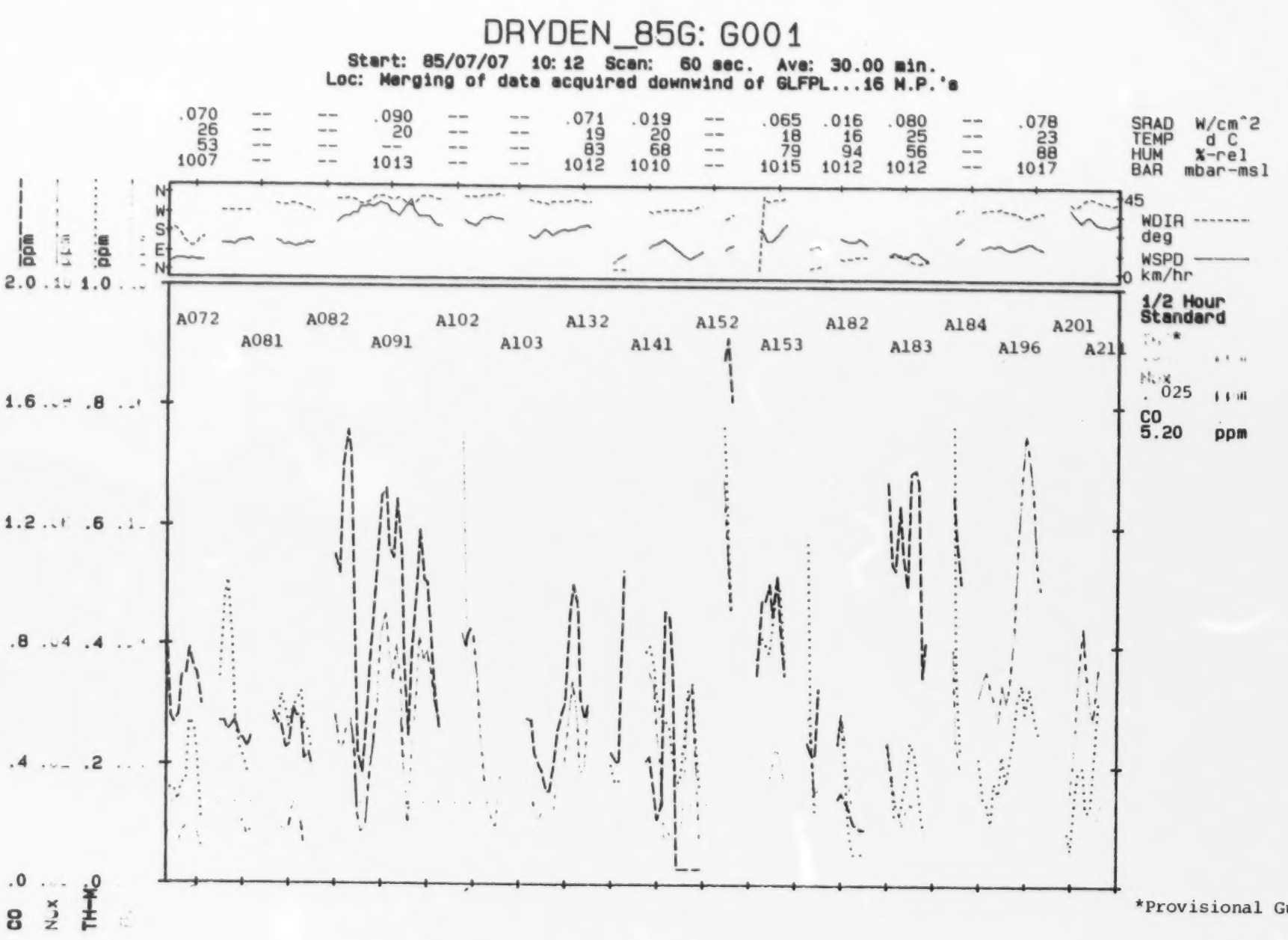


Figure 13

*Provisional Guideline

On these days, that is, July 9, 10 and 19th, the in-stack measurements of TRS were only 90, 120 and 105 ppm respectively. These in-stack concentrations were all below the theoretical benchmark of 160 ppm but the actual point of impingement measurements resulted in exceedances of the Provincial Guideline. Brisk to strong winds (20 to 40 km/hr) were present on these three days and this resulted in plume downwash, a condition a not covered by the theoretical calculations.

From the statistical summmary of the merged data set for these 16 monitoring periods, the overall average glc of TRS was 0.017 ppm and the maximum one-minute average glc was 0.307 ppm. (The odour threshold for TRS is approximately 0.005 ppm).

Also, from this same merged data set, the maximum 30-minute average glc's of CO was 1.82 ppm; of TH-M 0.71 ppm; of NO_X 0.074 ppm; and of O_3 0.013 ppm.

From the analyses of the 31 GC samples acquired downwind of this mill, all loadings were considered to be low or at background levels. For these samples, the average total hydrocarbon loading was 88 ug/m^3 (with minimum and maximum loadings of 33 and 213 ug/m^3) with essentially equal loadings of the alkane and aromatic fractions (an average of 33 ug/m^3 (38%) and 22 ug/m^3 (25% respectively)). On the average, only 8 ug/m^3 of chlorinated organics (with a maximum loading of 18 ug/m^3) and 25 ug/m^3 of 1-isopropyl-4-methyl benzene (with a maximum loading of 86 ug/m^3) were detected in these samples. For all the other organics (up to 124 in total) and on the average, all loadings were less than 10 ug/m^3. By contrast to these findings, similar analyses were performed on 12 samples acquired in downtown Toronto. Here the total hydrocarbon loadings averaged 323 ug/m^3 with the alkane fraction comprising 62% of these totals and the aromatic fraction 22%.

A final note regarding these 31 GC samples is that the average precent area of identified peaks was 61%. For the downwind lagoon samples, this percent ranged from 34 to 58%. Thus, on the average, more success was obtained in the analyses of these 31 samples that the lagoon samples.

3. Upwind Monitoring:

Apart from the Ministry of Natural Resources (MNR) site which will be discussed in the next sub-section, only the monitoring site associated with MP A083 could be considered as an upwind site - i.e. a locale directly driven to after the downwind monitoring programme had been completed for the day. (Refer to daily printouts in appendix).

Concentration measurements upwind of a source are anticipated to be at or near background levels. This was not the case for MP A083. Although all the other common contaminant concentrations were at background levels, the acquired glc's of TRS were significant. As reported for this period, the maximum 1-minute and 30-minute average TRS glc's were 0.013 and 0.011 ppm respectively. Thus a secondary source of TRS was deemed to be prevalent in this area. After an investigation, this site was found to be directly downwind of the town's sewage treatment plant. Two GC samples were acquired at this site, but only very low loadings of total hydrocarbons were reported (59 and 43 ug/m^3) and they were composed almost entirely of alkanes (43%) and aromatics (40%). No chlorinated organics were detected and the only other major organic detected was 1-isopropyl-4-methylbenzene which had loadings of 11 and 4 ug/m^3.

Thus this aforementioned site could not be considered as a true upwind site since the results were being influenced by the emissions from the sewage treatment plant. However, for the majority of the time, the results obtained at the MNR site could be considered as being upwind since this site was usually outside the impingement zone for emissions from the mill, lagoon and the sewage plant and upwind of the potential sources.

Apart from the overnight monitoring programme, extensive calibrations were carried out at the MNR site. With respect to the GC, normally after calibration, a ambient air sample was acquired and subsequently analyzed. The results from all of these samples were similar - i.e. loadings reported at background levels. An example of one of these runs is reported for monitoring period A074. The total hydrocarbon loading was 90 ug/m^3 with the majority of this loading attributable to the alkane fraction (74%). The aromatic fraction only comprised 16% of this loading and no chlorinated organics were detected.

4. Overnight Monitoring at Ministry of Natural Resources:

In contrast to the short-term monitoring described in the previous sections, data at the MNR location was collected over periods from 15 to 20 hours, usually from mid to late afternoon until early the following morning. Only one GC sample was collected at this location (during MP A074). It was considered to be upwind sample and was discussed in the previous sub-section.

The data from the 15 monitoring periods acquired at the MNR site was merged and is presented in Figure 14. This figure shows the 30 minute runnning mean concentrations for TRS, TH-M, NO_x and CO for each monitoring period, as well as the wind speed and direction.

With respect to the total reduced sulphur results, it can be seen that there were considerable periods of time when the levels of TRS were below the minimum detectable level (0.002 ppm) of the instrument. These periods are shown as the horizontal straight line portions of the graph. (Since these concentrations could be anywhere from zero to 0.002 ppm they are assumed to be 1/2 the minimum detectable level, i.e. 0.001 ppm, for purposes of calculations) It is also also evident from the many spikes, that significant concentrations of TRS were measured on many occasions. In fact, on 8 of the 14 monitoring periods when the TRS monitor was operating, levels above the nominal odour threshold of 0.005 ppm were measured.

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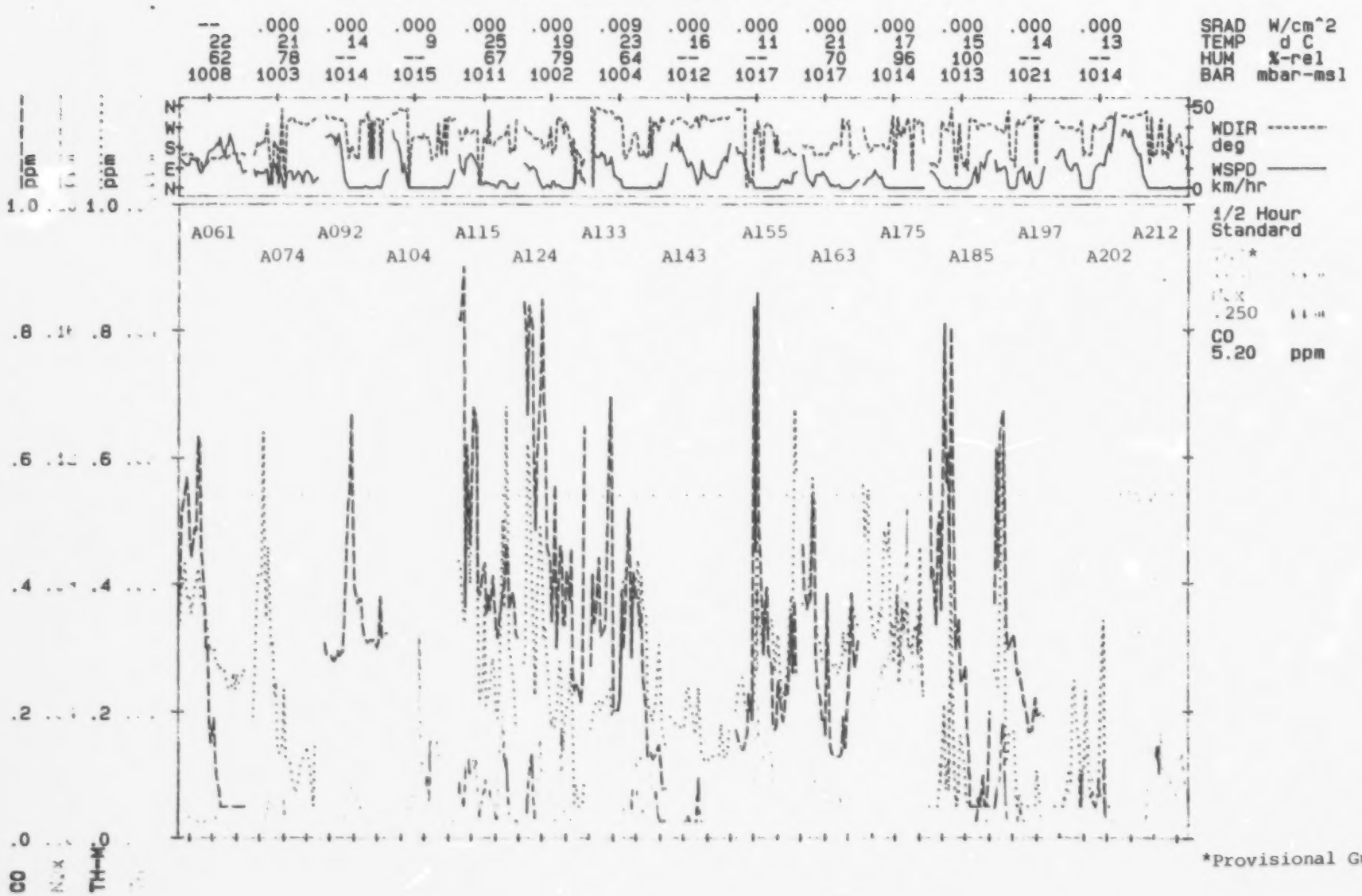
DRYDEN_85A: M001
Start: 85/07/06 14:42 Scan: 300 sec. Ave: 30.00 min.
Loc: Merging of all data acquired at MNR site .... 15 M.P.'s
-- .000 .000 .000 .000 .000 .009 .000 .000 .000 .000 .000 .000 .000
22 21 14 9 25 19 23 16 11 21 17 15 14 13
62 78 -- -- 67 79 64 -- -- 70 96 100 -- --
1008 1003 1014 1015 1011 1002 1004 1012 1017 1017 1014 1013 1021 1014
SRAD W/cm^2
TEMP d C
HUM %-rel
BAR mbar-msl
WDIR
deg
WSPD
km/hr
50
0
1/2 Hour
Standard
.250
CO
5.20 ppm
A061 A074 A092 A104 A115 A124 A133 A143 A155 A163 A175 A185 A197 A202 A212
ppm
1.0
.8
.6
.4
.2
.0
CO
TH-HC
*Provisional Guideline

Figure 14

The highest 30-minute average concentration of TRS was 0.037 ppm and it occurred during MP A115 from 9:24 to 9:54 pm. At this time, the average wind speed was 13 km/hr and the wind direction was 259°. In relation to the MNR site, the recovery boiler stack was located 1600 m away at approximately 250°, while the lagoon was 2200 m distant at between 270-280°. It is also significant to note during this study that the highest daily average TRS emission of 210 ppm from the recovery boiler was recorded on this day as shown in Table 6. Only on this occasion during the overnight monitoring periods was the Provisional TRS Guideline of 0.027 ppm exceeded. This occurred from 9:19 to 10:04 ppm for a duration of 45 minutes.

To obtain an overview of wind direction associated with TRS concentrations, a wind rose and a pollutant rose diagram were plotted from the merged data set as shown in Figure 15. From this analysis, the most common wind condition was calm which occurred 40% of the time. The next most frequent condition was for the wind blowing from the northwest and west for 17% and 13% of the time respectively. Southwest winds occurred only 3% of the time. However, the highest average TRS concentrations were measured when winds were from the southwest and west. Thus, results inferred that the major source of the TRS measured at the MNR site originated from the mill complex located to the west-southwest.

With respect to CO, NO_X and TH-M, all concentrations measured at the MNR site were low. From the merged data set, the maximum 30 minute averages for carbon monoxide, oxides of nitrogen,and non-methane hydrocarbons were 2.6 ppm, 0.11 ppm and 0.84 ppm respectively. Pollutant roses were also plotted for each of these pollutants as shown in Figures 16 to 18 respectively. They show that the major sources for these pollutants were located to the south and southwest of the MNR site, which corresponds to the town of Dryden.

5. **Particulate Monitoring:**

The results of the particulate monitoring program in the vicinty of the lagoon are presented in Table 7. At each of the four locations, from 11 to 13 samples were collected. The average total suspended particulate concentrations ranged from 17 ug/m^3 at the Smith residence 300 m north

DRYDEN_85A: M001

Start: 85/07/06 14:42 Scan: 300 sec. Ave: 30.0 min. Duration: 258.3 hrs.
Loc: Merging of all data acquired at MNR site .... 15 M.P.'s

WINDS Blowing Towards
1 Division = 10% of Time
Calm (< 3 km/hr) = 40.1%

High (>100 km/hr) = .0%

TRS Blowing From
1 Division = .01 ppm -- A. MEAN

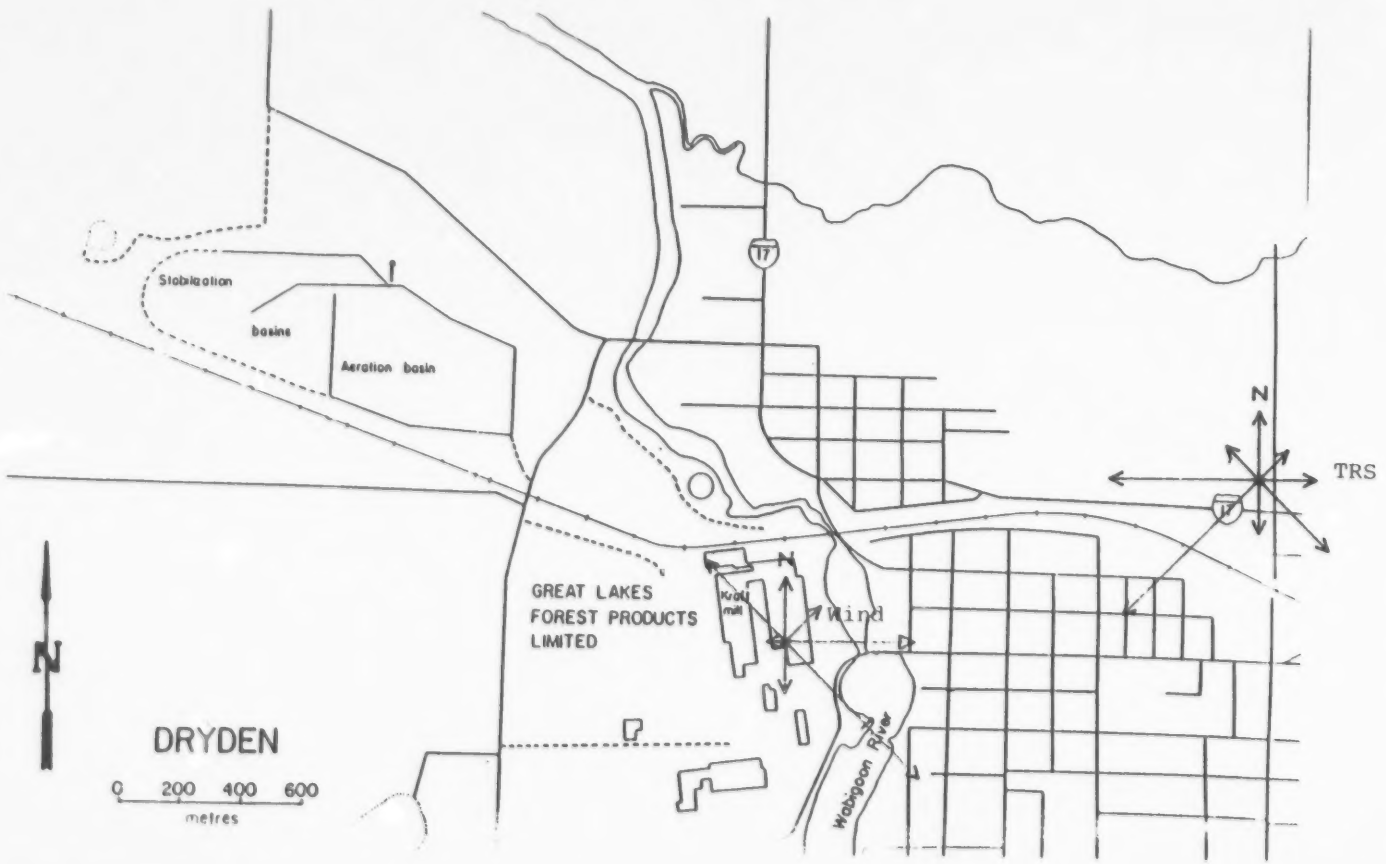

Figure 15

DRYDEN_85A: M001

Start: 85/07/06 14:42 Scan: 300 sec. Ave: 30.0 min. Duration: 258.3 hrs.
Loc: Merging of all data acquired at MNR site .... 15 M.P.'s

WINDS Blowing Towards
1 Division = 10% of Time
Calm (< 3 km/hr) = 40.1%

High (>100 km/hr) = .0%

CO Blowing From
1 Division = .1 ppm ---- A. MEAN

Figure 16

DRYDEN_85A: M001

Start: 85/07/06 14:42 Scan: 300 sec. Ave: 30.0 min. Duration: 258.3 hrs.
Loc: Merging of all data acquired at MNR site .... 15 M.P.'s

WINDS Blowing Towards
1 Division = 10% of Time
Calm (< 3 km/hr) = 40.1%

High (>100 km/hr) = .0%

NOx Blowing From
1 Division = .1 ppm -- A. MEAN

Figure 17

DRYDEN_85A: M001

Start: 85/07/06 14:42 Scan: 300 sec. Ave: 30.0 min. Duration: 258.3 hrs.
Loc: Merging of all data acquired at MNR site .... 15 M.P.'s

WINDS Blowing Towards
1 Division = 10% of Time
Calm (< 3 km/hr) = 40.1%

High (>100 km/hr) = .0%

Non-CH4 Blowing From
1 Division = .1 ppm -- A. MEAN

Figure 18

Table 7

Particulate Monitoring Results

Total Suspended Particulate (ug/m^3)

Date 1985	Location			
	Matthews S;150m	Wilson SW;500m	Johnston Pk. E;750m	Smith N;300m
Sun July 7	52	51	34*	35*
Mon July 8	-	47	44*	18
Tues. July 9	-	51	41*	12
Wed. July 10	21	69	67	18
Thurs. July 11	45*	19	47*	23*
Fri. July 12	23*	52*	45*	7
Sat. July 13	23*	9	31*	5
Sun. July 14	11	14	16*	10
Mon. July 15	38*	30	11	16
Tues. July 16	208	237	66*	7
Wed. July 17	81	106	48	37*
Thurs. July 18	20*	-	-	-
Fri. July 19	16*	-	-	-
Sat. July 20	28*	-	-	-
Sun. July 21	29*	-	-	-
Number of Samples	13	11	11	11
Average	46	62	41	17
Geometric Mean	33	42	36	14

*Denotes: Trace Amounts of Foam on the Filter

of the lagoon, to 62 ug/m^3 at the Wilson residence 500 m southwest of the lagoon. The corresponding geometric means were 14 ug/m^3 and 42 ug/m^3 respectively.

All of the total suspended particulate results were below the desirable ambient air quality criterion of 120 ug/m^3 except for 2 samples collected on Tuesday July 16 at the Mathew and Wilson locations. A microscopic examination of the collected particulate from both of these locations showed that the particulate consisted of sharp edged, fractured crystalline particles, which are typical of road dust and from an analysis of the winds on this day, it was concluded that the major source of these high particulate levels was the dirt road (i.e. Wilson Rd.) which was immediately south of both sampling locations.

A visual examination of the Hi-Vol filters showed that some foam particles were collected at all locations. At the Johnston Park location, 8 out of 11 filters had trace amounts of foam, while at the Wilson location only 1 filter out of 11 revealed some foam. In every case the amount of foam collected was too small for a quantitative determination of loading. The foam appeared on the filters as a few to several dark brown flecks.

Conclusions:

In this section only the most significant points identified by this study are presented. The reader is referred to the previous sections of the report for a full discussion of any these items.

In point form, here are the findings.

1. **Lagoon Study:**

- Significant concentrations of TRS (total reduced sulphur) compounds were measured on company property surrounding the lagoon. The maximum 1-minute average concentration of TRS was in excess of 12.5 ppm and the maximum 30-minute average concentration was 0.539 ppm.

- Off plant property, the concentrations of TRS decreased rapidly as the downwind distance increased. At nearby residences, the concentrations were in excess of the odour threshold for TRS (approximately 0.005 ppm) however, no exceedance of the Provisional Environmental Guideline (0.027 ppm) was measured.

- Carbonylsulphide and carbon disulphide measurements at the lagoon indicated essentially uniform concentrations (all below 0.04 ppm) throughout the different areas of the lagoon. These concentrations were below the standard (0.10 ppm) for carbon disulphide. There are no standards or guidelines for carbonylsulphide.

- The lagoon was also found to be a source of non-methane hydrocarbons (TH-M). The maximum 30-minute average concentration of TH-M as measured at the surface of this lagoon was found to be 29.51 ppm. Similar to the TRS findings, these concentrations decreased rapidly as the downwind distance from the lagoon increased. Beyond approximately 175 metres, the concentrations of TH-M were at or near background levels. No Environmental Standards, Criteria nor Guidelines exist for TH-M.

- The average total hydrocarbon loadings on plant property beside the lagoon ranged from 219 to 652 ug/m^3. For these totals, the aromatic fraction dominated and accounted for up to 74% of all the organics detected.

- The most prominent aromatic was 1-isopropyl-4-methylbenzene (p-cymene). Its maximum concentration was 1741 ug/m^3 but this is only 0.2% of the concentration reported to cause skin irritation.

- Small amounts of chlorinated organic compounds were detected in these GC samples. The most prominent of these was trichloromethane (chloroform) and its maximum concentration was 197 ug/m^3. The Environmental Guideline for this organic is 1500 ug/m^3.

- The concentrations determined by GC analyses followed the TH-M results. Thus at downwind distances greater than 175 metres, the GC analyses reflected background hydrocarbon concentrations.

- Apart from TRS and non-methane hydrocarbons, the concentrations of the other continuously monitored contaminants were at or near background levels.

2. **Main Mill Complex:**

- Downwind of this mill complex, the TRS Provisional Guideline (0.027 ppm) was exceeded during 4 of the 16 monitoring periods. The maximum 30-minute average ground level concentration (glc) of TRS was 0.154 ppm. - i.e. over 5 times the Guideline. The TRS odour threshold (i.e. approximately 0.005 ppm) was exceeded during all 16 monitoring periods.

- For the other continuously monitored contaminants, background concentrations were measured.

- From the analyses of 31 GC samples acquired downwind of the mill, all hydrocarbon concentrations were considered to be at or near background levels.

3. **Overnight Monitoring (at the MNR site):**

- The TRS odour threshold was exceeded during 8 of the 15 monitoring periods.

- On one occasion, the TRS Provisional Guideline was also exceeded. The maximum 30-minute average TRS glc was 0.037 ppm and this coincided with reported high TRS stack measurements at the mill.

- The other continuously monitored concentrations were at or near background levels.

4. **Particulate Matter (vicinity of the lagoon):**

- Levels of total suspended particulate were generally very low. The highest geometric mean recorded at any of the four sites was 42 ug/m^3.

- Forty six particulate samples were acquired and 2 of these had total suspended particulate loadings in excess of the applicable Air Quality Criterion of 120 ug/m^3. However, the major cause of the high readings in these two samples was road dust.

- Small amounts of foam were occasionally detected on filters exposed at each of the four sampling locations. However, the amounts were too small to the quantified.

Table 8a
Gas Chromatographic Anlaytical Results
as Acquired at the Surface of GLFPL Main Lagoon
Units ug/m^3

	A122		A172		A173	A174	A193		A194
Total Hydrocarbon Loadings	271	234	500	2083	1284	735	454	246	59
Alkanes	121	91	128	53	117	123	78	27	6
Alkenes	9	9	11	5	10	-	2	1	6
Aromatics	106	102	302	1947	1084	528	103	97	27
Chlorinated Organics	19	22	40	81	53	-	221	121	19
Butane	17	7	14	4	12	22	-	6	2
Pentane	9	4	14	6	9	13	5	3	1
Hexane	5	3	5	1	-	-	8	2	-
Toluene	9	8	9	5	21	14	5	3	1
Benzene	7	5	6	3	9	17	33	19	4
Xylene	12	13	10	5	15	21	-	-	-
Trichloromethane	8	11	19	35	53	-	196	117	19
1-isopropyl-4-Methylbenzene	34	19	228	1741	866	274	62	69	18
Area % Identified Peaks	34	16	29	15	7	10	47	54	48

Table 8b
Gas Chromatographic Analytical Results
as Acquired at the Surface of GLFPL
Main Lagoon
Units ug/m^3

	# Entries	Arith Mean	Std. Dev.	Min. Load	Max. Load
Total Hydrocarbon Loadings	9	652	647	59	2083
Alkanes	9	83	45	6	128
Alkenes	8	7	4	-	11
Aromatics	9	483	646	27	1947
Chlorinated Organics	8	72	70	-	221
Butane	8	11	7	-	22
Peantane	9	7	4	1	14
Hexane	6	4	3	-	8
Toluene	9	8	6	1	21
Benzene	9	11	10	3	33
Xylenes	6	13	5	-	21
Trichloromethane	8	57	66	-	196
1-isopropyl-4-methylbenzene	9	368	581	18	1741
Area % Identified Peaks	9	28	19	7	54

Table 8c
Gas Chromatographic Analytical Results
as Acquired Beside Main Inlet to Lagoon
units ug/m^3

	A112		A113	Arith. Mean	Std. Dev.	Min. Load	Max Load
Total Hydrocarbon Loadings	303	637	300	413	194	300	637
Alkanes	41	285	29	118	144	29	285
Alkenes	2	7	2	4	3	2	7
Aromatics	132	157	71	120	44	71	157
Chlorinated Organics	121	176	192	164	37	121	192
Butane	2	2	1	2	1	1	2
Pentane	1	100	1	34	57	1	100
Hexane	2	2	1	2	1	1	2
Toluene	2	2	2	2	0	2	2
Benzene	3	3	2	3	1	2	3
Xylenes	3	3	2	3	1	2	3
Trichloromethane	109	144	170	141	31	109	170
1-isopropyl-4-Methylbenzene	85	106	49	80	29	47	106
Area % Identified Peaks	26	37	34	32	6	26	37

Table 9a
Gas Chromatographic Analytical Results
as Acquired 5 Metres Above GLFPL
Main Lagoon Surface
units ug/m^3

		A112	A162	A171	A192
Total Hydrocarbon Loadings	311	206	248	266	63
Alkanes	136	69	145	77	6
Alkenes	14	8	14	8	2
Aromatics	84	76	58	154	36
Chlorinated Organics	62	49	23	19	19
Butane	20	16	33	21	-
Pentane	14	6	14	10	1
Hexane	7	2	5	3	1
Toluene	4	2	5	3	2
Benzene	2	2	4	4	8
Xylenes	6	3	6	3	2
Trichloromethane	24	30	14	-	19
1-isopropyl-4-Methylbenzene	20	25	7	124	21
Area % Identified Peaks	31	17	28	49	52

Table 9b
Gas Chromatographic Analytical Results
as Acquired 5 Metres Above GLFPL Main Lagoon Surface
Units ug/m^3

	# Entries	Arith. Mean	Std. Dev.	Min. Load	Max Load
Total Hydrocarbon Loadings	5	219	95	63	311
Alkanes	5	87	56	6	145
Alkenes	5	9	5	2	14
Aromatics	5	82	44	36	154
Chlorinated Organics	5	34	20	19	62
Butane	4	18	12	-	33
Pentane	5	9	6	1	14
Hexane	5	4	2	1	7
Toluene	5	3	1	2	5
Benzene	5	4	2	2	8
Xylenes	5	4	2	2	6
Trichloromethane	4	17	11	-	30
1-isopropyl-4-Methylbenzene	5	39	48	7	124
Area % Identified Peaks	5	35	15	17	49

Table 10a
Gas Chromatograph Analytical Results
as Acquired Downwind of the GLFPL Main Lagoon
Units ug/m^3

	A073			A154			A161		A195	
Total Hydrocarbon Loadings	35	40	38	33	23	17	40	18	78	105
Alkanes	19	21	19	11	7	3	23	6	7	12
Alkenes	6	6	5	3	2	2	9	3	4	4
Aromatics	11	13	14	17	12	12	8	10	29	36
Chlorinated Organics	-	-	-	-	-	-	-	-	38	51
Butane	3	3	3	4	2	1	8	2	3	3
Pentane	1	1	1	2	1	-	3	1	2	3
Hexane	1	1	1	-	-	-	1	-	1	1
Toluene	1	1	2	1	1	1	1	1	1	2
Benzene	4	3	5	2	2	2	2	2	4	4
Xylenes	1	1	1	1	1	1	1	1	-	-
Trichloromethane	-	-	-	-	-	-	-	-	18	42
1-isopropyl-4-Methylbenzene	3	6	3	14	8	8	4	6	22	29
Area % Identified Peaks	37	57	48	55	60	58	69	60	26	42

Table 10b
Gas Chromatograph Analytical Results
as Acquired Downwind of the GLFPL Main Lagoon
Units ug/m^3

	# Entries	Arith Mean	Std. Dev.	Min Load	Max Load
Total Hydrocarbon Loadings	10	43	28	17	105
Alkanes	10	13	7	3	23
Alkenes	10	4	2	2	9
Aromatics	10	16	9	8	36
Chlorinated Organics	2	45	9	38	51
Butane	10	3	2	1	8
Pentane	9	2	1	-	3
Hexane	6	1	0	-	1
Toluene	1	1	0	1	2
Benzene	10	3	1	2	5
Xylenes	8	1	0	-	1
Trichloromethane	2	30	17	18	42
1-isopropyl-4-Methylbenzene	10	10	9	3	29
Area % Identified Peaks	10	51	13	26	69

Table 11
Gas Chromatographic Analytical Results
as Acquired Upwind of GLFPL Mill and Lagoon
Units ug/m^3

	A074		A083	Arith. Mean	Std. Dev.
Total Hydrocarbon Loadings	90	59	43	64	24
Alkanes	67	23	21	37	26
Alkenes	6	8	6	7	1
Aromatics	14	27	14	18	8
Chlorinated Organics	-	-	1	-	-
Butane	11	3	3	6	5
Pentane	5	1	2	3	2
Hexane	3	1	1	2	1
Toluene	-	1	1	1	-
Benzene	3	9	3	5	3
Xylenes	3	1	2	2	1
Trichloromethane	-	-	-	-	-
1-isopropyl-4-Methylbenze	2	11	4	6	5
Area % Identfied Peaks	65	48	61	58	9

Table 12a
Gas Chromatographic Analytical Results
As Acquired Downwind of the GLFPL Mill
Units - ug/m^3

	A072			A081			A082				A091			
Total Hydrocarbon Loadings	86	74	67	144	213	79	71	79	93	58	113	50	64	105
Alkanes	44	50	41	66	150	50	18	30	23	26	15	8	10	6
Alkenes	11	6	10	11	27	10	4	9	8	7	1	5	3	-
Aromatics	30	18	15	50	30	15	46	26	52	25	92	37	50	99
Chlorinated Organics	-	-	-	11	1	-	2	8	8	-	3	-	-	-
Butane	11	17	13	11	59	13	5	5	4	5	-	1	1	-
Pentane	4	4	4	5	13	4	-	3	2	1	-	-	1	-
Hexane	2	2	1	3	4	2	-	1	1	1	1	-	-	-
Toluene	2	2	2	13	4	2	2	2	2	2	7	2	1	2
Benzene	10	6	6	12	14	4	8	4	8	3	13	2	2	6
Xylenes	2	2	2	11	4	3	2	2	2	2	5	1	2	2
Trichloromethane	-	-	-	-	-	-	2	4	5	-	-	-	-	-
1-isopropyl-4-methylbenzene	12	3	3	2	3	2	30	13	35	13	55	28	39	83
Area % Identified Peaks	72	63	69	68	82	67	50	55	64	47	42	63	64	72

Table 12b
Gas Chormatographaic Analytical Results
As Acquired Downwind of the GLFPL Mill
Units ug/m^3

	A102			A103		A132	A152	A153		A196	A201			
Total Hydrocarbon Loadings	104	45	218	48	131	86	101	146	33	74	57	55	59	130
Alkanes	23	15	119	10	16	45	38	84	6	17	28	20	23	62
Alkenes	5	3	3	3	4	7	5	8	-	5	3	-	-	9
Aromatics	52	22	66	33	98	32	45	36	27	31	22	32	31	51
Chlorinated Organics	11	2	16	2	9	1	7	15	-	19	-	-	-	-
Butane	3	3	4	1	3	10	8	34	2	5	7	6	4	8
Pentane	2	1	1	1	1	4	5	10	-	3	3	3	3	9
Hexane	1	1	-	-	1	2	2	2	-	1	1	1	1	5
Toluene	5	1	2	1	3	5	4	3	1	2	2	2	3	7
Benzene	6	2	4	2	4	5	4	3	3	4	4	3	4	5
Xylenes	5	2	2	1	2	9	4	3	1	-	3	2	3	7
Trichloromethane	9	-	9	-	4	-	-	-	-	10	-	-	-	-
1-isopropyl-4-methylbenzene	31	14	56	27	86	6	27	23	21	22	11	23	18	27
Area % Identified Peaks	70	56	58	53	70	55	51	84	64	27	72	61	72	81

Table 12c

Gas Chromatographic Analytical Results
As Acquired Downwind of the GLFPL Mill
Units ug/m^3

		A211		# Entries	Arith Mean	Std Dev.	Min. Load	Max Load
Total Hydrocarbon Loadings	57	44	46	31	88	46	33	213
Alkanes	11	9	19	31	35	33	6	150
Alkenes	-	-	-	24	7	5	-	27
Aromatics	26	34	23	31	40	22	15	99
Chlorinated Organics	18	-	-	16	8	6	-	18
Butane	3	4	5	29	9	12	-	59
Pentane	1	1	2	26	4	3	-	13
Hexane	-	-	1	26	2	2	-	4
Toluene	2	1	2	31	3	2	1	13
Benzene	6	4	4	31	5	3	2	14
Xylenes	1	1	3	30	3	2	-	11
Trichloromethane	9	-	-	8	6	3	-	9
1-isopropyl-4-Methylbenzene	15	28	13	31	25	21	2	86
Area % Indentified Peaks	54	16	66	31	61	15	16	84

Table 13
Summary of the Common Contaminant Measurements
Acquired During The 1985 Dryden Survey

Site/Source	# of M.P.'s	# of hrs	Max. 60-Minute Average Conc. TRS	TH-M	CO	NO_X	Overall Mean Conc. TRS	TH-M	CO	NO_X	Comments
MNR-Site	15	247.3	0.022	0.67	0.86	0.08	0.002	0.24	0.34	0.01	Overnight Monitoring & Usually upwind
			Max. 30-Minute Average Conc.**								
GLFPL-source	16	36.4	0.103	0.71	1.82	0.07	0.017	0.27	0.73	0.02	Downwind Monitoring
Lagoon-Source	5	10.7	0.024	0.50	1.35	0.03	0.009	0.26	0.49	0.01	Downdwind Monitoring
GLFPL-upwind	1	1.1	0.010	0.08	0.32	0.01	0.008	0.08	0.32	0.01	Downwind Sewage Treatment Plant
			On Plant Property - At Lagoon								
Lagoon-Source	5	7.7	0.538	2.54	-	0.03	0.056	1.32	-	0.01	5 Metres above SFC
Lagoon-Source	4	5.0	0.097	27.00	7.39	0.09	0.051	8.89	2.03	0.02	At Lagoon Surface
			C_XS_X								
Lagoon-Source	4	5.7	0.047	24.60	1.66	0.02	0.019	5.67	0.67	0.01	At Lagoon surface
Total	50	3.3.9									

*Instantaneous TRS Concentrations were Measured in Excess of 12.5 ppm
** Provisonal TRS Guideline Applicable ..... 0.027 ppm

APPENDIX

ARB-223-85-AQ&M

Daily Statistics - Common Contaminants

- GC samples

Merged Data Sets

Tabular Print-Outs of the One-Half Hour Average Pollutant Concentrations

As Acquired by MAMu #1 on a Continuous Basis during the Dryden GLFPL Ambient Air Survey of July, 1985

The following statistical print-outs are one-half hour average ground level concentrations, reported every 5 minutes and are the pollutant concentrations, in parts per million (ppm), as monitored at the sites and time periods as listed in Tables 1a and 1b.

The pollutants presented are carbon monoxide (CO), total hydrocarbons (THC), cabonylsulphide and carbon disulphide (C_xS_x), total reduced sulphur (TRS), non-methane hydrocarbons (Non-CH_4), methane (Methane), oxides of nitrogen (NO_x), nitrogen dioxide (NO_2), nitrogen monoxide (NO) and ozone (Ozone).

The meteorological parameters are treated in the same statistical manner and are also included in these print-outs. The specific units appear on the last page of the print-outs and all of these instruments were mounted in MAMu #1.

Upon examining the specific averages, a few notations will become evident - these are:

"-" Invalid data / not Calculated ..refers to data that has been edited out of the data set due to instrument malfunction, the instrument not set up in the approved acquisition mode, missing data (eg. calibrations, time loss due to power loss, etc.) or data that was not deemed to be indicative of the true environment at the particular monitoring site (e.g vehicular exhaust, etc). All of this data was considered invalid and does not appear in any of the calculations.

"nd" Average is less than the minimal detectable limit for the particular analyzer. This is valid data and the average was then set to 1/2 the minimal detectable level and used in the calculations. For each pollutant, each of the minimal detectable levels are noted on the last page of the print-outs.

Since one-half hour average glc concentrations are presented, 90% of valid data readings must be present in order for an average to be valid. In other words, since the scan time is 60 seconds, only 3 scan values can be omitted from the calculations of the 30-minute average concentration.

Gas Chromatograpic Results

Dual-capillary column analysis was performed for each air sample on a Hewlett Packard 5880A Gas Chromatograph equipped with a Trace Organic Preconcentrator. For the gas chromatograph (GC), a computer library containing approximately 120 organic compounds was utilized to identify many of the hydrocarbons recorded by the GC.

Each day, a calibration mixture of hydrocarbons was injected into the gas chromatograph. The retention times for these organic compounds were used as references from which retention indices of unknown peaks in the chromatograms of the air samples were calculated.

For each analysis, a computer progam calculated the retention index for each peak in both chromatograms and a comparison was made with the library values. An Identification Report was printed for each column. If the retention index for a peak, as eluted on a specific column, fell within a retention index window specified for a library entry, the organic compound was identified and the calculated amount was printed in the Indentification Report. A final Confirmation Report, resulting from the merging of the analysis from the two chromatograms, was printed giving the name of each compound identified on both chromatograms and the best value for the amount of each compound.

The analytical results are summarized in table form for all the air samples analyzed during this survey. The study name, date acquired and sampling times for each analysis are listed across the top of the table. If the compound was detected on both columns for a given analysis, then the amount for that compound is stated (the units are micrograms per cubic meter-ug/m^3). No amount value is stated for a compound if that compound was found only on one column or if it was not detected on either column. A further summary of each analysis is given at the bottom of the table for the particular time period sampled. The more important of these summary entries are the total hydrocarbon loadings (ug/m^3), a summary breakdown of the total into nine subgroups, the total number of peaks identified and the percentage of the total area credited to the identified peaks. Certain ratioed amounts of specific organic compounds are also presented and these ratioed amounts will be used for future studies as to source delineations.

RETENTION INDEX LIBRARY BENCHMARKS

MAMU#1

COMPOUND NAME	MINIMUM DETECTABLE AMOUNT (UG/M3)	STANDARD OR GUIDELINE 1/2HR AVERAGE (UG/M3)	TLVs TWA	TLVs STEL	TLVs C
PROPANE	.2				
PROPADIENE	.3				
PROPYNE	.3				
CHLOROMETHANE	.3	20000 (2)	105000	205000	
CYCLOPROPANE	.3				
ISOBUTANE	.3				
VINYL CHLORIDE	.3	560 (2)	5000	10000	
1-BUTENE	.3				
1,3-BUTADIENE	.3				
BUTANE	.2		800000		
1-BUTYNE	.3				
CHLOROETHANE	.3		2600000	3250000	
3-METHYL-1-BUTENE	.3				
2-METHYLBUTANE	.3				
1-PENTENE	.3				
PENTANE	.2		1800000	2250000	
ISOPRENE	.4				
TRANS-2-PENTENE	.2				
DICHLOROMETHANE	1.5	100000 (1)	350000	1740000	
2-METHYL-2-BUTENE	.3				
2-CHLORO-2-METHYLBUTANE	.2				
3-CHLOROPROPENE	.5				
2,2-DIMETHYLBUTANE	.2				
3-METHYL-1-PENTENE	.2				
2,3-DIMETHYLBUTANE	.2				
3-METHYLPENTANE	.2				
1-HEXENE	.3				
CIS-1,2-DICHLOROETHYLENE	.3		790000	1000000	
2-CHLOROBUTANE	.6				
HEXANE	.3	35000 (2)	180000		
CHLOROFORM	2.2	1500 (2)	50000	225000	
TRANS-3-HEXENE	.3				
3-CHLORO-2-METHYLPROPENE	.3				
METYHYLCYCLOPENTANE	.2				
1,2-DICHLOROETHANE	.7		40000	60000	
1,1,1-TRICHLOROETHANE	1.0	350000 (1)	1900000	2450000	
1-CHLOROBUTANE	.4				
BENZENE	.2	10000 (1)	30000	75000	
CARBON TETRACHLORIDE	.9	1500 (2)	20000	125000	
CYCLOHEXANE	.2	300000 (2)	1050000	1300000	
2-METHYLHEXANE	.5				
2,3-DIMETHYLPENTANE	.3				
CYCLOHEXENE	.3		1015000		
DIBROMOMETHANE	18.4				
3-METHYLHEXANE	.5				
1,2-DICHLOROPROPANE	.6				
2,3-DICHLOROPROPENE	.7		5000	50000	
TRICHLOROETHYLENE	.3	85000 (1)	270000	1080000	
2,2,4-TRIMETHYLPENTANE	.2				
1-HEPTENE	.3				
HEPTANE	.2		1600000	2000000	
1-CHLORO-3-METHYLBUTANE	.3				
TRANS-2-HEPTENE	.3				

METHYLCYCLOHEXANE	.2			1600000	2000000
2,5-DIMETHYLHEXANE	.5				
4-METHYLCYCLOHEXENE	.3				
1-CHLOROPENTANE	.4				
1,1,2-TRICHLOROETHANE	1.1				
TOLUENE	.2	2000	(1)	375000	560000
1,3-DICHLOROPROPANE	.7			350000	510000
2-METHYLHEPTANE	.2				
1,2-DIBROMOETHANE	2.1				
1-OCTENE	.4	150000	(3)		
TRANS1,2DIMETHYLCYLOHEXANE	.3				
TRANS-4-OCTENE	.3				
TETRACHLOROETHYLENE	.9			335000	1340000
OCTANE	.3			1450000	1800000
2-METHYL-1-HEPTENE	.3				
2-OCTENE	.6				
CIS-1,2-DIMETHYLCYCLOHEXANE	.3				
CHLOROBENZENE	.4			350000	
PROPYLCYCLOPENTANE	.3				
ETHYLCYCLOHEXANE	.2				
1-CHLOROHEXANE	.5				
ETHYLBENZENE	.3	4000	(1)	435000	545000
M-XYLENE+P-XYLENE	.3	2300	(4)	435000	655000
STYRENE	.8	400	(1)	215000	425000
1,4-DICHLOROBUTANE	.2				
O-XYLENE	.3	2300	(4)	435000	655000
1,1,2,2-TETRACHLOROETHANE	2.6				
1,2,3-TRICHLOROPROPANE	1.3			300000	450000
1-NONENE	.7				
NONANE	.3			1050000	1300000
ISOPROPYLBENZENE	.3	100	(3)		
2-CHLOROTOLUENE	.5				
3-CHLOROTOLUENE	.5				
N-PROPYLBENZENE	.4				
4-CHLOROTOLUENE	.5				
3-ETHYLTOLUENE	.4				
4-ETHYLTOLUENE	.4				
1,3,5-TRIMETHYLBENZENE	.4			125000	170000
2-ETHYLTOLUENE	.4				
T-BUTYLBENZENE	.3				
1,2,4-TRIMETHYLBENZENE	.4	100	(1)	125000	170000
1,3-DICHLOROBENZENE	.8				
1-DECENE	1.3	180000	(3)		
4-CHLOROTOLUENE	4.3				
1,5-DICHLOROPENTANE	.3				
DECANE	.5				
SEC.BUTYLBENZENE	.3				
3-(CHLOROMETHYL)-HEPTANE	.3				
1,2,3-TRIMETHYLBENZENE	.4			125000	175000
1-ISOPROPYL-4-METHYLBENZENE	.5				
1,2-DICHLOROBENZENE	.3				300000
INDAN	.5				
N-BUTYLCYCLOHEXANE	.4				
1,3-DIETHYLBENZENE	.4				
1,4-DIETHYLBENZENE	.5				
N-BUTYLBENZENE	.3				
1,2-DIETHYLBENZENE	.5				
DECALIN	.3				
UNDECANE	.8				
1,2,3,5-TETRAMETHYLBENZENE	.6				
DIISOPROPYLBENZENE	.8				
1,2,3,4-TETRAMETHYLBENZENE	.9				
TETRALIN	.6				
DODECANE	1.3				

Notes: (1) Standard
(2) Guideline
(3) Provisional Guideline
(4) Provisional Guideline for sum of o-,m-, & p-xylene

TLVs - Threshold Limit Values - American Conference of Governmental Industrial Hygienists
TWA - Time Weighted Average for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed without adverse effect
STEL - Short Term Exposure Limit - concentration to which workers can be exposed for a short period of time (15 minutes) without adverse effect
C - Ceiling - concentration that should not be exceeded even instantaneously